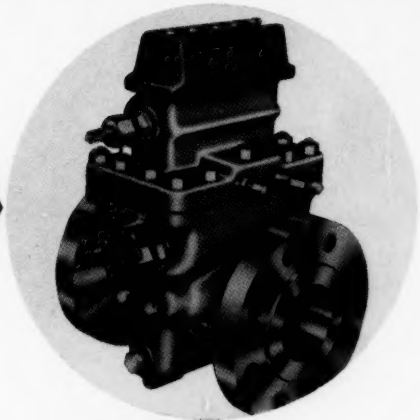
Les Driskell,
Instrument Engineer ..1851

INSTRUMENTS and AUTOMATION

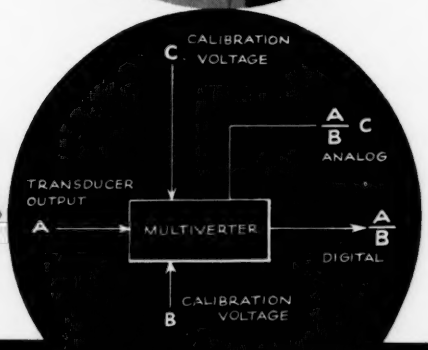
OCTOBER 1957

Orifice Fittings For
Rapid Plate Removal ..1900



Foreman Monitors Plant
Via ITV 1892

Hybrid Analog-Digital
Computing Systems 1877



Including: Instrument Manufacturing • Journal of the SCMA • Simulation Council Newsletter

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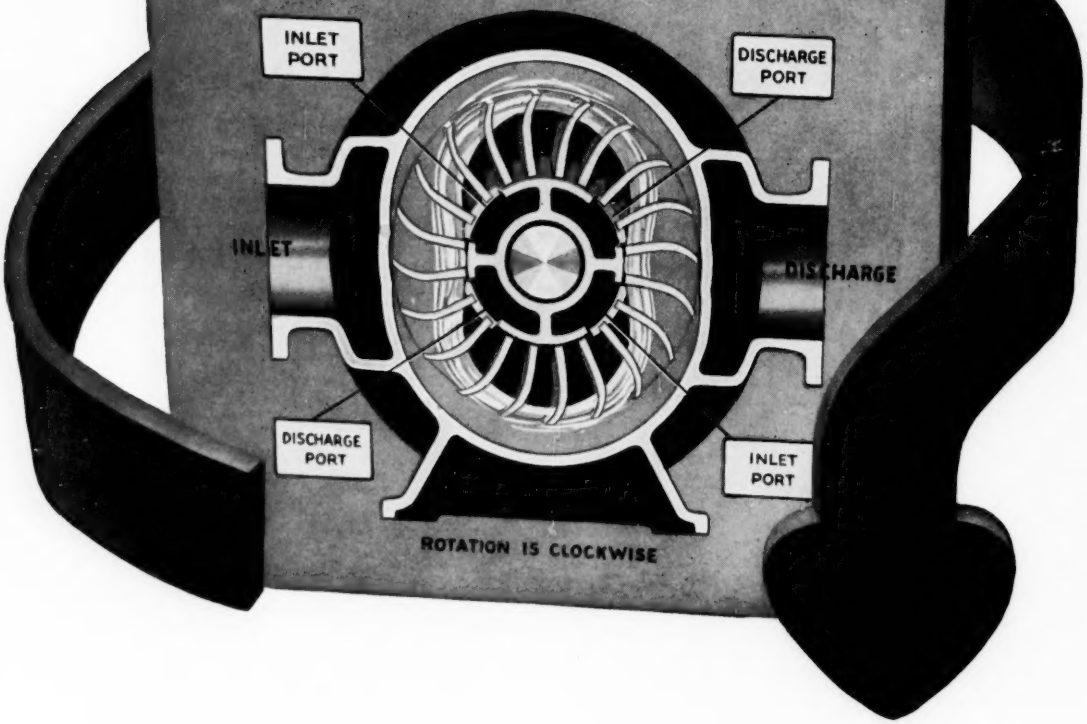

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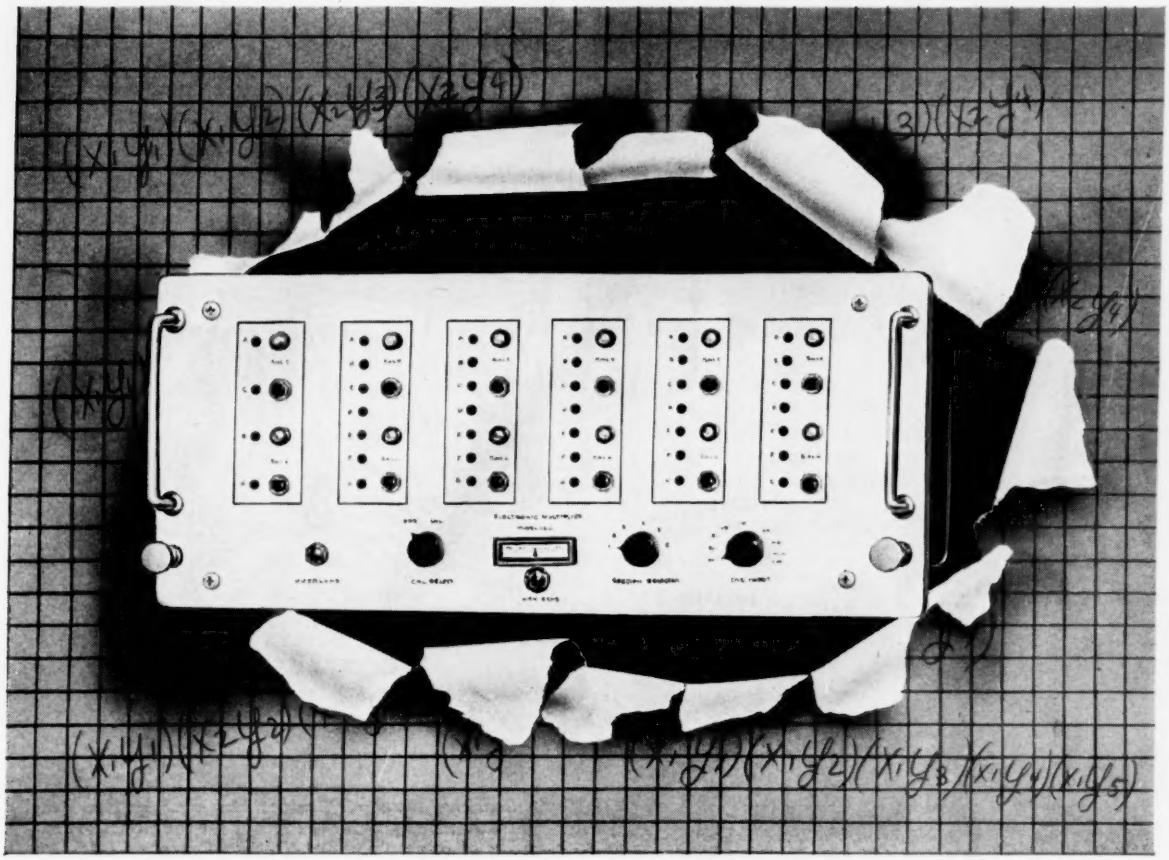
IT'S HERE-



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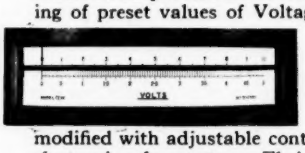

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INSTRUMENTS and AUTOMATION

EDITED FOR USERS OF MEASUREMENT AND CONTROL INSTRUMENTS

Volume 30, No. 10
October 1957
Part 1 of Two Parts

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Editorial

Review of 12th Annual I.S.A. Conference and Exhibition 1871

Feature Articles

Hybrid Analog-Digital Computing Systems 1877
Max Palevsky

Analog Integrating of Transient Waveforms 1881
Ralph C. Leibowitz

Domestic Regulators 1885
C. S. Beard

Finding Natural Frequency Quickly 1890
Leslie R. Axelrod

Engineering ITV Applications 1892
Joseph W. Belcher

Electronic Circuitry 1894
Charles F. Kezer and Milton H. Aronson

High-Temperature Measurements 1896
H. M. Beede

Journal of the Southern California Meter Association

Board of Directors—Year 1957-58 1899

Orifice Fittings and Meter Tubes 1900
Ralph C. Clemons, Jr.

The Simulation Council Newsletter 1909

Other Regular Features

Letters to the Editor	1820	Books	1864
Inquiries	1823	New Instruments	1916
Trends	1826	Briefs	1970
Panhandle Pete	1828	New Literature	1980
News	1834	Searchlite Section	1990
Biographies of Significance	1851	Advertiser's Index	1992
Events	1859	Inquiry Card	1993

THE MAGAZINE OF INSTRUMENTATION AND AUTOMATIC CONTROL SINCE JANUARY 1928

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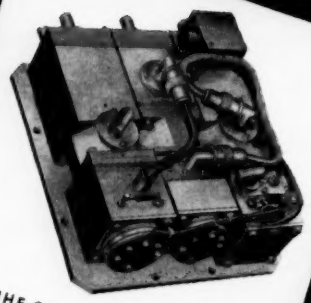

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Letters to the editor

Editor, I&A:

I will be grateful if you would send me by air mail: (1) Subscription for three years to I&A. (2) Copy of "100 *Electronic Circuits*". (3) Copy of *Computer Handbook No.* 1. (4) Copy of *Computer Handbook No.* 2.

I use this opportunity for expressing my satisfaction with your magazine. You are doing a really fine job.

The only thing I can tell you is that your publication could be in Spanish; I could myself offer hundreds of subscriptions.

Ing. Oscar R. Grace
Toloso, Argentina

Editor, I&A:

After nearly three years of wading through conference proceedings for new and provocative material, I am inclined to agree with your editorial, "Needed: Better Program Management!" It saddens me to think of the paper, ink and effort put into these dismal publications.

Margaret Milligan, Editor
Data Processing Digest
Los Angeles, Calif.

Here is an editor who should know!

Editor I&A:

Please subscribe us for five years to your fine magazine. Enclosed is a check. Thank you.

The magazine is good for the advertising that we get out of it. Then the circuits that you publish under the special circuits pages are very helpful; finally the articles on computers are useful to us from time to time. Both for information and education do we appreciate the magazine.

John Sehlmeier
General Manager
Electronic Brain Enterprises, Inc.
Salt Lake City, Utah

A clean sweep in satisfaction.

Editor, I&A:

Have been lucky enough to be able to purchase your fine book, "*Electronic Circuitry for Instruments and Equipment.*"

However, I find that in order to fully appreciate the material it contains, it would be appreciated if I could have an answer book to the questions.

Could you either send me an answer book, or advise me where I may obtain one?

N. G. Lonsdale
Seattle, Washington

Editor, I&A:

I have your book, *Electronic Circuitry for Instruments and Equipment*, 1953 Edition, which I use in coaching a group of science students. I find the book very helpful and informative.

I would like to get a key or list of the correct answers to the Test Item Quizzes at the back of the book as a check against my own answers. These young people can certainly ask very sharp and intriguing questions.

John L. Platz
Brooklyn 38, N. Y.

A list of answers is available to all who want them. The answers were not sent with each book in the first edition because the book is being used extensively in teaching—and we felt that teachers such as Mr. Platz would prefer their students not to have the answers in advance. In the second edition the answers are included.

Editor, I&A:

Thank you very much for having made available to us two copies of *Electronic Circuitry for Instruments and Equipment*, for our internal technical training program.

After quite a thorough survey of technical literature available which we might want to use for the Brush school, it seemed that your book offered the best general approach to the elements of instrument engineering for men of varied educational backgrounds.

We expect to make very good use of these books and are looking forward to the release of your new edition.

D. E. Pierce, Manager
Instrument Department
Brush Electronics Company

The 2nd edition is now available at $2.00.

RAMBLINGS ON INSTRUMENTATION

Are manufacturers' representatives human?

Everybody knows that manufacturers' representatives are (1) uneducated and technologically incompetent, (2) interested only in making a buck, (3) unfamiliar with the products they sell. In order to confirm these hoary generalizations we conducted a survey of our sales force (all independent manufacturers' representatives, incidentally). Somehow the results *don't* support the above conclusions; to wit:

64% of the sales and service personnel of our representatives have college engineering or science degrees (BSME is the most popular degree). Almost without exception those who do not possess formal college degrees have taken or are taking extensive night and correspondence courses in engineering and science subjects. Nearly 20% are Registered Professional Engineers.

70% belong to at least one engineering or industrial society (ISA was the most popular with ASME second). Of this "joiner" group one out of three (35%) has served his society in some elective office (e.g. Section President, Board Member, National Delegate, etc.). Of course, our most glittering example of society service is Judd Vollbrecht of Energy Control Company, New York, who is just completing his term as National President of The Instrument Society of America.

A surprising number are also involved in community and fraternal activities like JC's, Chamber of Commerce, Rotary, Boy Scouts, Elks, Masons, K of C, etc.

On top of this, a check of attendance records at our Product and Service Training Schools here in Michigan City and Regional Sales Refresher Courses throughout the country reveals that the salesman or serviceman gets training from factory personnel at least once every two years, frequently more often. Furthermore, in order to keep you posted on our products and their performance, he must read reams of "poop" (catalogs, service tips, instructions, installation stories, etc.) which spew forth from "the Factory" every week as well as put up with (and maybe learn something from) the Hays engineers who visit his territory at the darndest times.

All in all, this adds up to a picture of an "average" (and they hate this term) Hays' representative as being a pretty well educated guy who not only works hard at making a buck but also finds time to (a) keep learning on a regular basis about the products he sells (b) help advance technology through society activity (c) make his community a better place in which to live.

Did it just happen that we have this kind of personnel working for both you and us? No—it has taken a lot of effort alone and in co-operation with other manufacturers in a venture called Industrial Marketing Associates.

I'll elaborate more on IMA next month.

Incidental Intelligence (Toward-One-World Division)

We just learned of the experiences of a group of engineers who built a limited vocabulary computer for fast translation of English to Russian and vice versa. Seems the boys decided to feed in English phrases for translation to Russian, then requested the computer to re-translate to English. First test was the phrase "The spirit is willing, but the flesh is weak"—it came back "The ghost is ready, but the meat is raw." Next they tried "out of sight, out of mind" and became much more sympathetic with Mr. Dulles when the following spewed forth—"Invisible Idiot."

Phil Sprague Jr.
President

THE HAYS CORPORATION • MICHIGAN CITY, INDIANA

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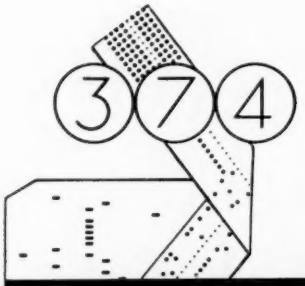

in engine test facilities–from measurement input to system output *– reliability you can count upon*

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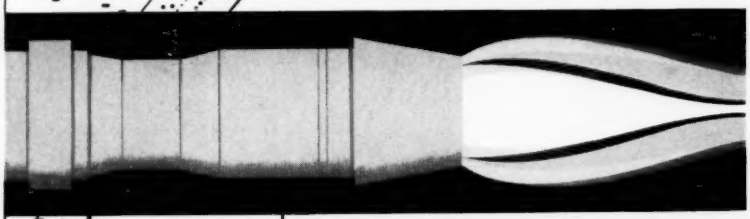

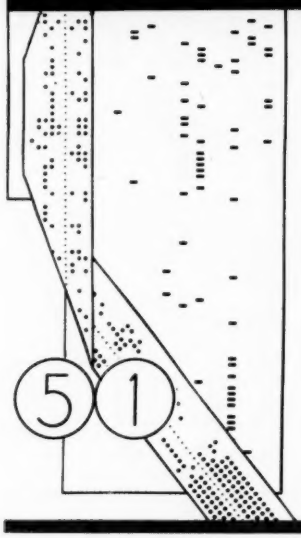

As many as 500 variables of pressure, temperature and other inputs are measured and recorded by the S-100 during test stand runs of rocket, jet and certain reciprocating engines. At sampling and readout rates of one per second or beyond, depending upon requirements, the information provided by Vibrotron® Digital Pressure Transducers, Digital Shaft Converters and millivolt and frequency signals is processed against stored calibration data. Sequentially or upon demand, this processed information may be routed through format control to system outputs for tabulations, visual readout, punched cards, tape or other output media.

Bulletin 58-112 details application of the S-100 System to a representative automatic data handling and recording system for engine test facilities. You are invited to request your personal copy and to specify your particular requirements.

S-100 System

Vibrotron® Digital Transducer

Technical Bulletins relative to Vibrotron Digital Transducers, Digital Shaft Converters, Miniature Magnetic Memory Drums, Etched Circuit Component Cards and other system components and accessories are available upon request.

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LETTERS—CONTINUED

Editor, I&A:

I have read with interest your *COMPUTER HANDBOOK* (1955) and followed the interesting series of articles beginning in the October, 1955, *Instruments and Automation* on Digital Computers, and am writing to ask if you have re-published that series in separate form and issued any subsequent editions of the handbook?

I have also been much interested in Mechanical Translation as developed at MIT and other institutions and would like to know if there is any recent material published on Mechanical Translation since *Machine Translation of Languages*, edited by William N. Locke, was published by Wiley and Sons, 1955?

F. Kenneth Mayer
San Jose, Calif.

The Digital Automation Series will be available in book form in about 60 days. The Second Edition of the Computer Handbook is now available ($2.00).

Reader Inquiries

Metal Detector

Industrial engineer in processing laboratory seeks compact, inexpensive metallic detector device capable of scanning approximately 125 cu ft of waste cardboard and paper. A-264

Clouding Control

Vice president of laboratory instrument manufacturer desires photoelectric circuit to detect and control (by relay actuation) the clouding of liquid caused by temperature changes. A-265

A-C Network Analyzers

Agency for large computer manufacturer seeks information on definition, uses, and markets for a-c network analyzers. A-266

Hydraulic and/or Pneumatic Foot Valves

Consulting engineer requests list of manufacturers of foot valves, hydraulic and pneumatic. A-267

Photoelectric Cells

German manufacturer of electrical meters seeks list of American suppliers of photoconductive cells. A-268

INQUIRIES—CONTINUED

Paper Thickness Meter Static Eliminator

Manager of Yugoslavia paper mill seeks non-contacting paper thickness gage; also static eliminator. A-269

Pen-light-battery Motor

Instrument manufacturer seeks sources of supply for electric motor operating on pen-light battery. A-270

Miniature Switch Market

Advertising agency requests information on market for original equipment and replacements of miniature snap-action switches. A-271

Linear Differential Transformer

Superintendent of technical department of artificial fibre spinning mill seeks sources of supply for linear differential transformers. A-272

Survey on Static Solid-state Elements

Representative of overseas petroleum company seeks publication survey on static solid-state elements. A-273

High-frequency and High-amplitude Ammeter

Manager of French chemical plant seeks sources of supply for "ammeters measuring average current drawn by motors, of high frequency and high amplitude. Believes thermal ammeters (e.g. with bi-metal) will satisfy needs. A-274

Bond of Silver to Copper

Head of Plastic Dept. of slip-ring manufacturer wishes to measure degree of molecular bond between large ring of electro-deposited silver (13" dia) and ¼"-dia copper rod, bonded by non-conductive material. A-275

Adhesive Quality of Tape

Engineer of company manufacturing composition material seeks commercial source of testing instrument to determine tackiness or adhesive quality of pressure-sensitive tape. A-276

One tape can't serve all recording needs in magnetic instrumentation

There are differences between pulse and carrier recording . . . therefore the tapes used in these systems must have different characteristics. Only in Soundcraft Instrumentation Tapes are these distinct and separate properties engineered into the oxide formulation. Soundcraft then adds two original processes — Uni-Level Coating and Micropolishing — to achieve the surface perfection found exclusively in the most advanced tapes of our time:

Soundcraft Type A Tape for Digital Recording

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Get the Soundcraft Tape that's made for your application . . . get error-free recording!

RCCH oxide formulation gives "Type A" higher signal output and greater retentivity plus unique surface hardness for controlled tape wear rather than uncontrolled equipment wear.

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R14

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Brochure, Type B Tape ☐

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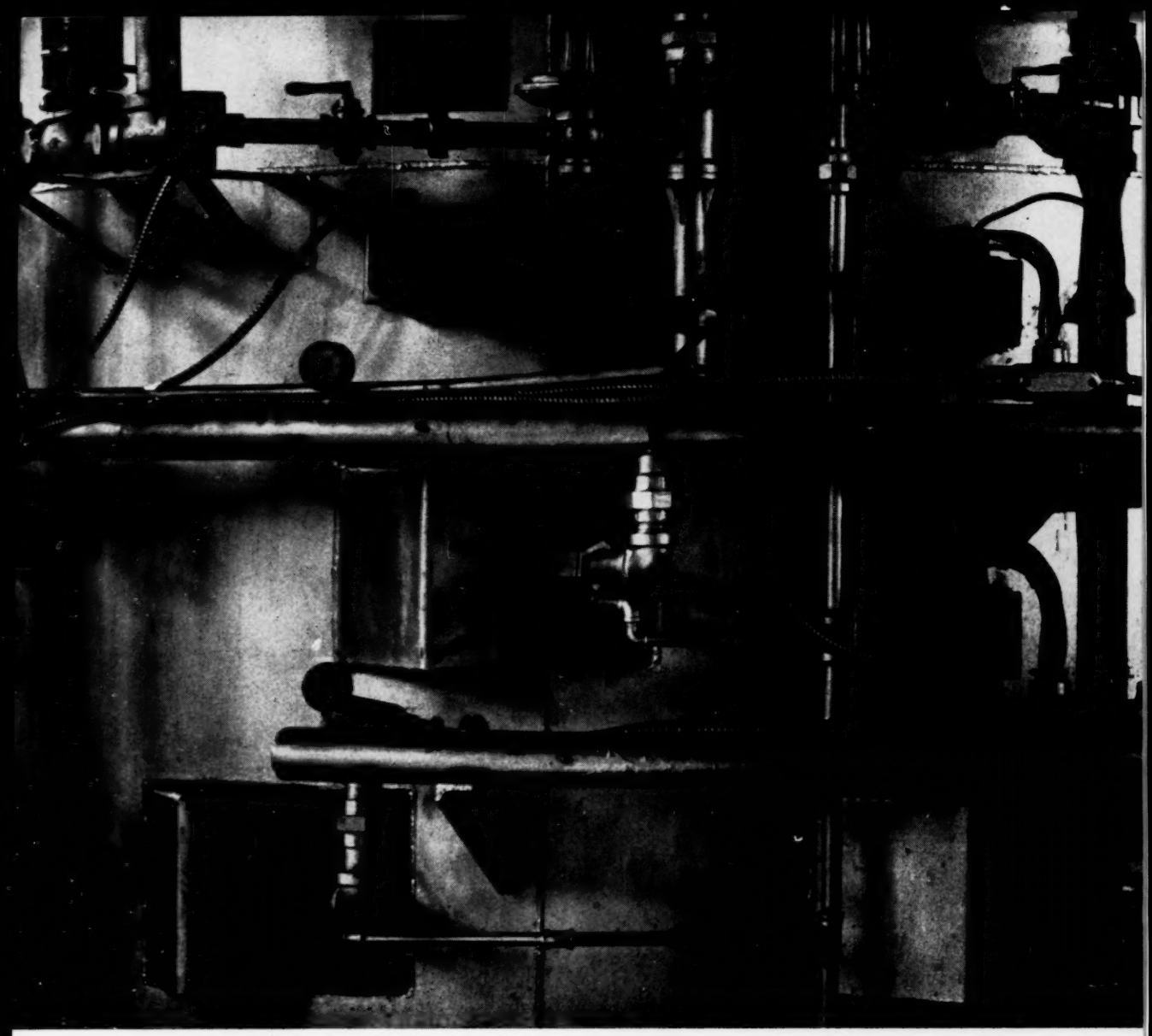


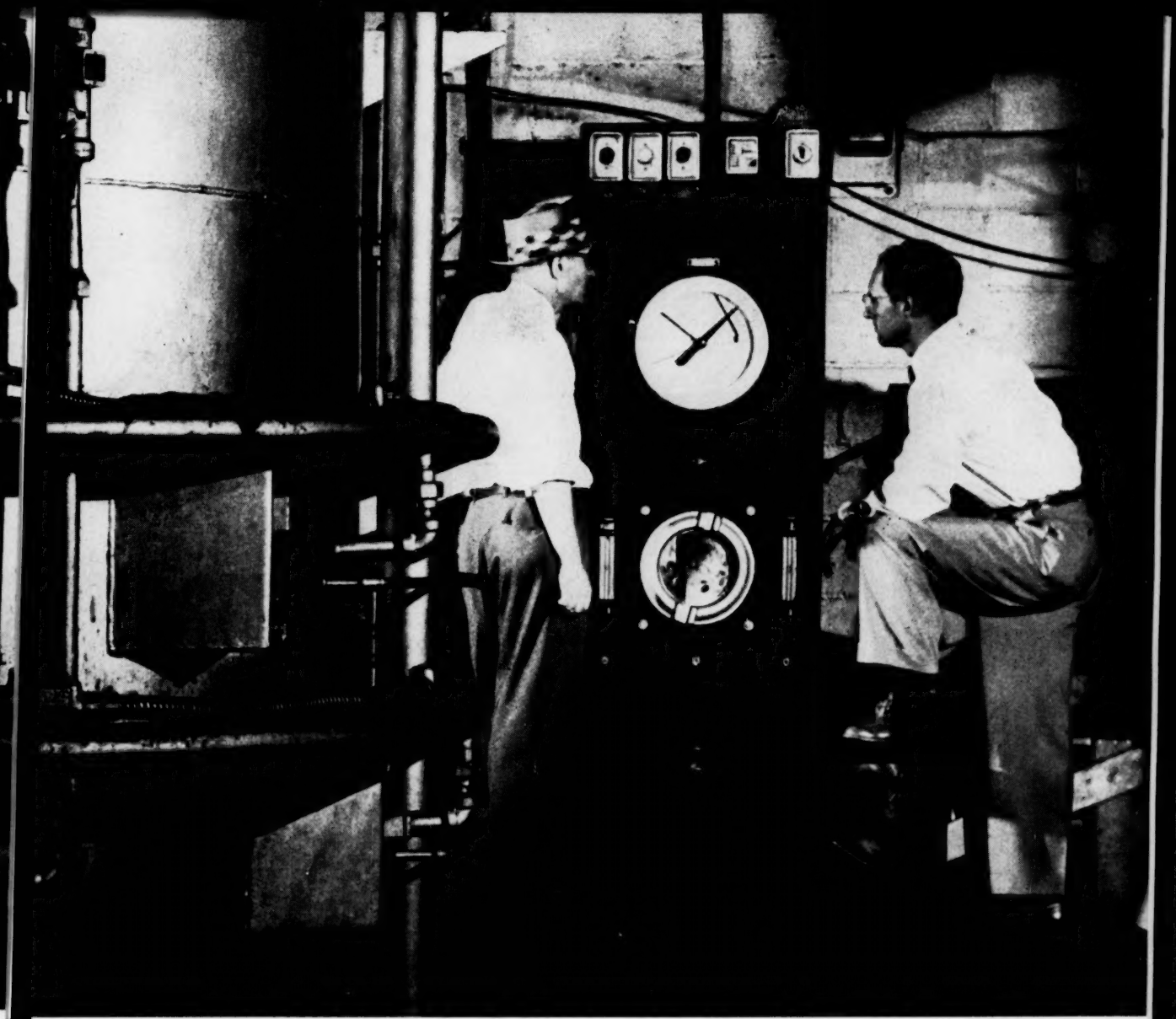
Engineering follow-up on M-S-A® assures dependable performance

The performance of an MSA gas analyzer—*after installation*—is a major concern of ours. That's why we place so much stress on engineering follow-up.

Briefly, here's what this service means to you. To make sure your analyzer is dependable, there's an MSA Instrument Specialist available to instruct plant personnel in the operation and maintenance of the new instrument. And while he doesn't get in on the piping or wiring connections, he'll be by to see that your gas analyzer is doing the job for which it was ordered.

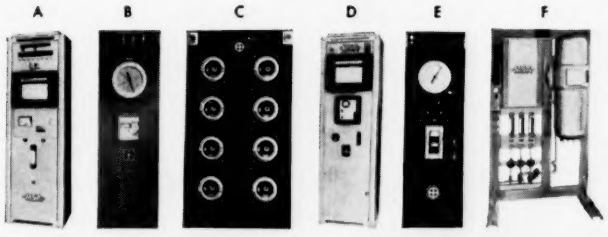
This in-the-plant observation is just the beginning of the MSA man's continued interest in your satisfaction. He's on call to help you. So next time you have a process stream problem, talk to him first. For the name of the MSA man nearest you, or for specific information on any of our basic units, just write.

For more information circle 9 on inquiry card.



This MSA Field Service Engineer (right) is discussing gas analysis on a follow-up call with a plant superintendent. The M-S-A Inert Gas Analyzer which he's checking, is solving a number of complicated annealing furnace problems.

gas analyzers from the start



A. M-S-A (LIRA) Infrared Analyzer
B. M-S-A Inert Gas Analyzer
C. M-S-A Combustible Gas Analyzer
D. M-S-A Gas Thermatron
E. M-S-A Oxygen Indicator
F. M-S-A Water Vapor Recorder

INSTRUMENT DIVISION

MSA

MINE SAFETY APPLIANCES COMPANY
Pittsburgh 8, Pennsylvania

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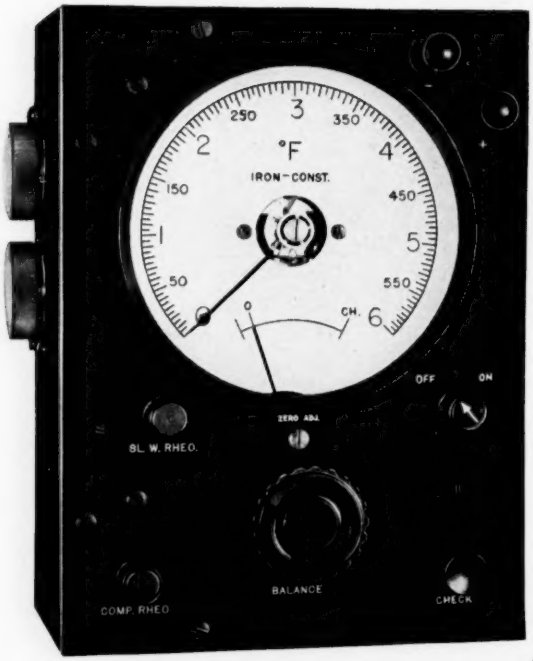
LEWIS MODEL 73 PO

PORTABLE

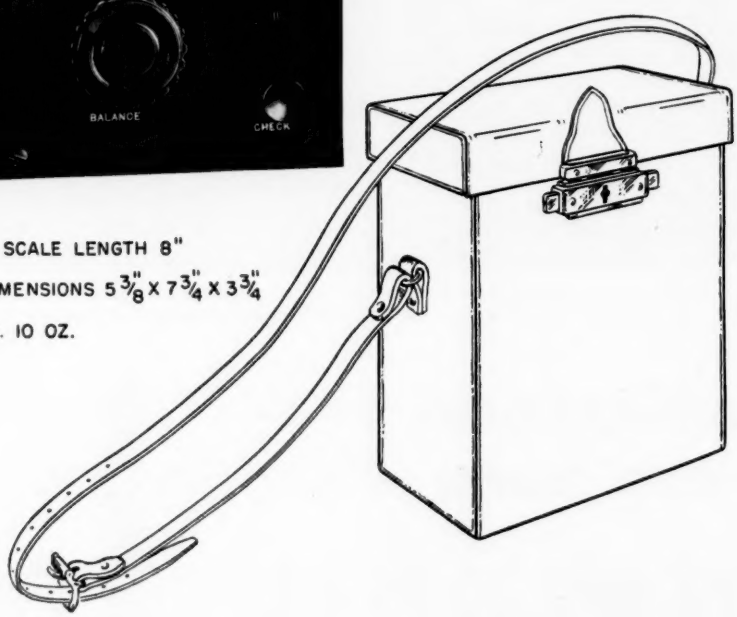
PYROMETER POTENTIOMETER



FOR MEASURING TEMPERATURES
electrically

- IN MOVING VEHICLES
- IN AIRCRAFT
- IN THE LABORATORY

30 STANDARD RANGES AVAILABLE TO FIT MOST REQUIREMENTS



TEMPERATURE SCALE LENGTH 8"

INSTRUMENT DIMENSIONS $5\frac{3}{8}" \times 7\frac{3}{4}" \times 3\frac{3}{4}"$

WEIGHT 4 LBS. 10 OZ.

THE LEWIS ENGINEERING CO.

NAUGATUCK, CONNECTICUT

Manufacturers of Complete Temperature Measuring Systems for Aircraft

For more information circle **10** on inquiry card.

INSTRUMENTS and AUTOMATION Trends

Radioactivity is already in general use in measurement, including tracer technique. But industrial uses of radioactivity (supplanting or replacing techniques of mixing, heat, light, catalytic action, etc.) are increasing rapidly, including refining of crude oil, preservation of food sterilization and pasteurization, catalytic action in chemical reactions, vulcanization of rubber.

Magnetic tape is finding new expanding uses in data handling, instrumentation, telemetering, computing, etc., etc. Sales are now running at about $12 million/year.

First steel company to purchase general-purpose analog computer for purpose of simulating operations is Jones & Laughlin, Pittsburgh, Pa., which has received delivery of an Electronic Associates' PACE computer. Other steel firms are expected to follow soon. This marks first—and long awaited—breakthrough into industrial simulation of operations. Orchids and a place in instrument history go to Richard Webster of J & L.

Microwave cooking (2400-2500 Mc) is expanding field; 2500 were sold in 1956; 3000 are expected to be sold in 1957; 100,000 in 1962 (GE estimate); 250,000 in 1965 (Raytheon estimate).

Chemosphere—the upper atmosphere above about 50 miles—is a new and exciting laboratory, now that rockets with instruments can penetrate it. Strong ultraviolet radiation from sun keeps atmospheric gases ionized and produces chemical reactions not yet understood.

Digital computer market is estimated today at $250 million annually, mainly business and data processing. Industrial electronic computer market, reports RETMA, was $47 million in 1954, $72 million in 1955, $100 million in 1956.

Reading habits of Americans are terrible—and getting worse, reports American Institute of Public Opinion, which has been surveying reading habits for 20 years. At last survey, percentage of adults found reading books was: England–55%; Australia 34%; Canada 31%; USA–17%. Comparable figure in USA in 1937 was 29%. Books are an indispensable cement holding civilization together on a foundation of culture. The disease of ignorance and shallowness is fatal to ideals. We are afflicted already. Here is a problem of first magnitude.

Average college professor's salary is said to be $5,200— in actual purchasing power only 70% of what it was in 1940—while average factory worker's purchasing power is now 150% of 1940. This trend is dangerous to country.

Wallace Electronics Discovers Systems Engineering

Panhandle Pete

"I say, old chap, look here in this magazine what it says about applying Systems Engineering," remarked Dr. Otto. U. Alles gleefully one morning as he rode into my office on his pogo stick, waving one of the newer trade magazines in one hand and a Confederate flag in the other, "Just what I have been awaiting, Old Chap, a new technique for solving the age old problem of . . ."

"Of what causes the common cold. Ha! Ha! Ha! eh Cuz?" rudely interrupted Waldo Klapsaddle, who was lying in my hammock sharpening up old razor blades on the sole of his foot.

"Oh no, old chap, this is a very explicit and clear account of how to connect a computer into your process; after that one merely sits down and awaits the flood of money which will result. Fact is there is also a discussion of how to spend money foolishly, old chap, because there is going to be so much of it. And another thing I . . ."

"Now hold your horses, Cuz, ain't we makin' enough money to get by on?" said Waldo as he gracefully trimmed his corns, "If'en we sold many more products down here by golly we'd all have to go to work and ah, yuh, um, erp!" and Waldo yawned and fell asleep.

"OK, Doc, poor old Waldo has had a busy day," says I, apologizing for Waldo. "What are you trying to say? I thought you had an order for one gross of Himmelrakets and that was the reason for that hundred or so people out in the back yard."

"Certainly, old chap, but can't you see the glorious possibilities in a technique which would unite our Model O. J. Computer with all our other pick-ups—Par-Kometers, Aves Analyzers, and Goosey Gander Alarms? Now this block diagram I sketched off first thing this morning illustrates the principle; all we have to do is tailor it to fit WESCO!'s line of products. My assistant Dr. Oscar Fullbritch and I have it all worked out. No sir, we cannot afford to limp along with our old fashioned products, old fashioned superintendents, old fashioned instrument men, and old fashioned instruments. What we need, old chap, is Systems Engineering. No longer is it necessary to struggle along in Snafu or even Fubar when it is possible to arrive at the ultimate—Tarfu. After all, a colleague of mine, Signor Giavanni Piccalilli, demonstrated in 1901 by the following equation

$$\int_{\text{Aviation}}^{\text{Process}} \text{Feedback} + \sum_{0}^{\infty} \text{Nonsense} = \text{M.F.}^{*} + \text{S.E.}^{**}$$

that next to the invention of fire, Systems Engineering would, when it was discovered, solve all automation problems."

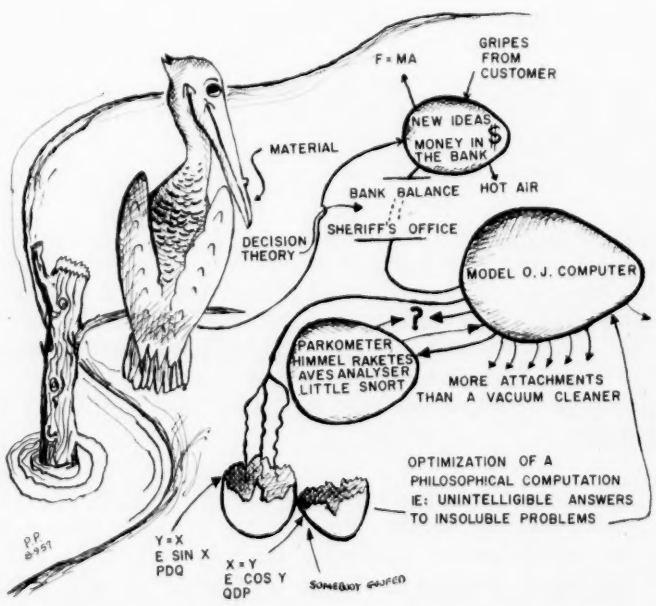
"But according to your diagram here, the O. J. Computer will handle both incoming materials and customer's gripes. What'll I do?" says I, recognizing this threat to my future security at first glance.

"You may indeed have to change your way of life," says Otto, "But you have no choice. Unless you apply Systems Engineering here, old chap, I must hand in my resignation and I don't mind telling you, old chap, us Systems Engineers are in great demand. In fact, I have already calculated a name for the company I am going to form with your hundred or so engineers and that order for 144 Himmelrakets! They have already agreed to join my new company at double their present salary. I can see it now, spread across all the technical press in big inky letters —OTTO-FULLBRITCH, SYSTEMS ENGINEERING (earth satellites and ditch digging on the side). Doesn't that sound impressive?" And Doc Alles leaped upon his pogo stick and dashed off in all directions.

Oh my gosh! What'll J. L. Wallace, Chief Engineer, do now? If I don't let Otto systems engineer our plant he'll quit and take my engineers; If I do let him we'll never get that order filled. "Hey Bus, who gave that trade journal to Otto to read? I would like a word with him."

Panhandle Pete

* Manless Factory
** Systems Engineering



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RECORD WIDTH	12 inches
MAGAZINE CAPACITY	200 feet
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POWER REQUIREMENTS	115 Volts—60 cps
TIMING LINES	0.01 and/or 0.10 second intervals
SIZE	11 1/16" x 16 13/16" x 24 1/2"
WEIGHT	130 pounds

MI

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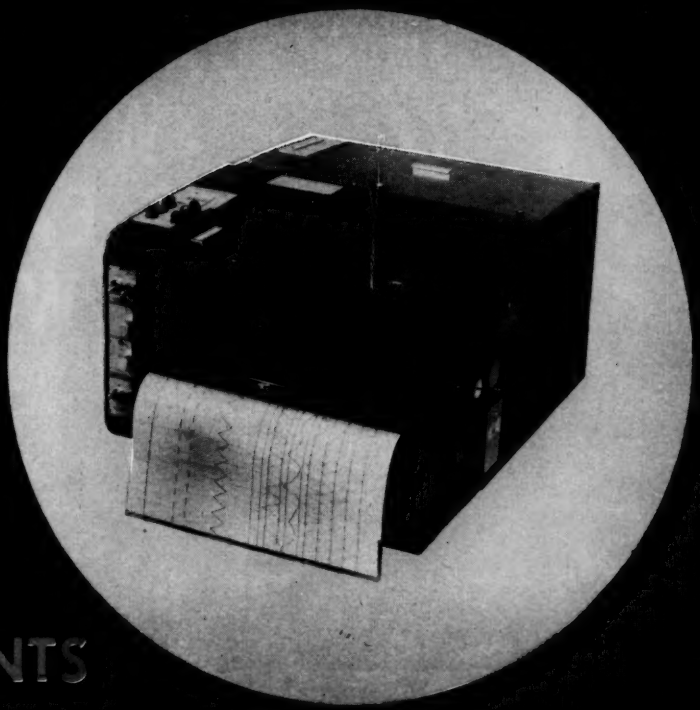

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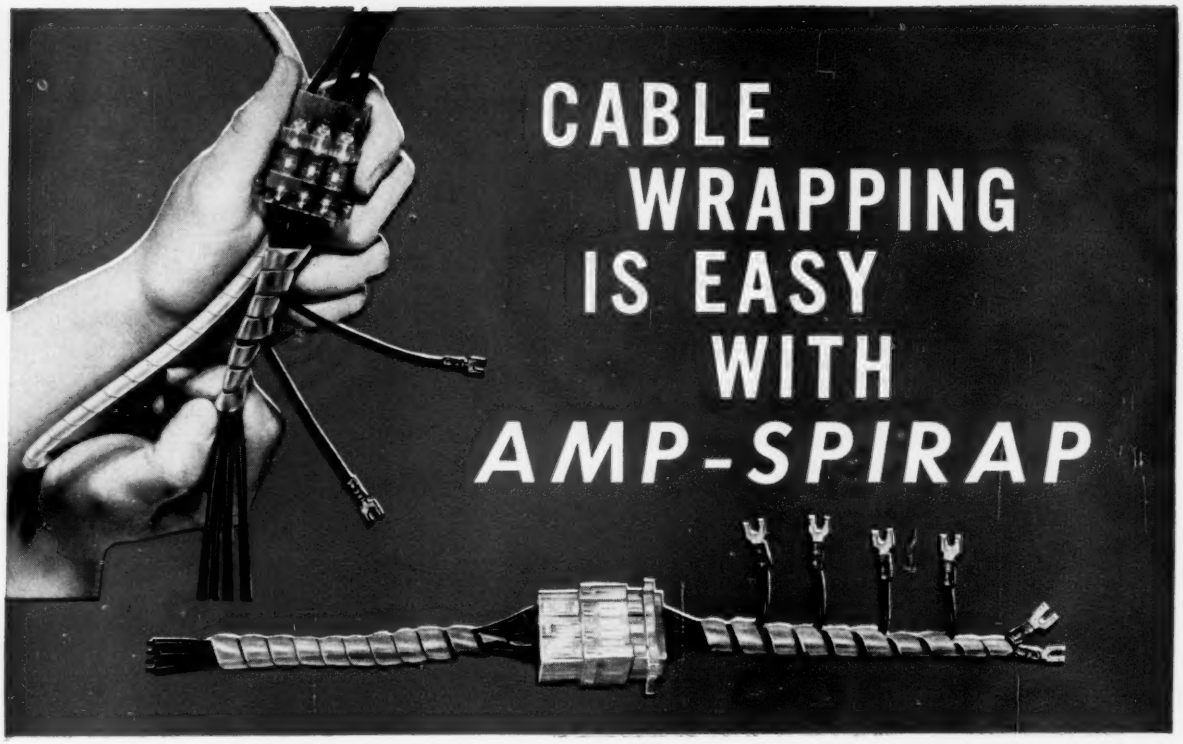

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For more information circle **13** on inquiry card.

Circle **14** on inquiry card. ⟶

GENERAL TRANSISTOR

MAXIMUM RATINGS AT 25°C — TYPICAL CHARACTERISTICS AT 25°C

General Transistor Type	Polarity	Transistor Dissipation (MW)	Collector to Base Voltage (Emitter Open) (Volts)	DC Collector Current (ma)	Peak Collector Current (ma)	Storage Temperature (°C)	AC Current Gain (Common Emitter) (β)	DC Current Gain (β) Conditions	DC Current Gain (β) Gain	Power Gain (DB)	Noise Figure (DB)	Collector Cutoff Current Conditions	Collector Cutoff Current (μa)	Alpha Cutoff Frequency (mc)	Collector Voltage (Volts)	Emitter Current (ma)	Applications
GT-14	PNP	125	25	100		85	28			36	16	VCB=10V	6		4.5	1	Audio, Gen. purpose
GT-20	PNP	125	25	100		85	42			40	16	VCB=10V	6		4.5	1	Audio, Gen. purpose
GT-34	PNP	125	25	100		85	15			32	16	VCB=10V	6		4.5	1	Audio, Gen. purpose
GT-74	PNP	125	25	100		85	75			42	<12	VCB=10V	6		4.5	1	Audio, Gen. purpose
GT-75	PNP	125	25	100		85	150			44	<12	VCB=10V	6		4.5	1	Audio, Gen. purpose
GT-81	PNP	125	25	100		85	75			42	16	VCB=10V	6		4.5	1	Audio, Gen. purpose
GT-81 HS*	PNP	150	25	200		85	120			44	16	VCB=10V	6		4.5	1	Audio, Gen. purpose
GT-82	PNP	125	25	100		85	150			46	16	VCB=10V	6		4.5	1	Audio, Gen. purpose
GT-109	PNP	125	25	100		85	120			44	16	VCB=10V	6		4.5	1	Audio, matched pair
GT-222	PNP	125	12	100		85	20			30	30	VCB=10V	6		4.5	1	Audio, Gen. purpose
GT-14 H	PNP	90	12	50		75	28			36	12	VCB=10V	6		4.5	1	Hearing Aid
GT-20 H	PNP	90	12	50		75	42			40	12	VCB=10V	6		4.5	1	Hearing Aid
GT-81 H	PNP	90	12	50		75	80			42	12	VCB=10V	6		4.5	1	Hearing Aid
GT-210 H	PNP	90	12	50		75	15-250			>34	>29	VCB=10V	<25		4.5	1	Hearing Aid
GT 759 R	PNP	90	12	100		75	25			24φ			6	2.5	4.5	1	R.F. & I.F.
GT-760 R	PNP	90	10	100		75	40			28φ			6	5	4.5	1	R.F. & I.F.
GT-761 R	PNP	90	10	100		75	70			32φ			6	11	4.5	1	R.F. & I.F.
GT-762 R	PNP	90	6	100		75	120			34φ			6	17	4.5	1	R.F. & I.F.
GT-83†	PNP	125	25	200	500	85	35-49			40	16		10	<.7	4.5	1	Low Speed Computer
GT-87	PNP	125	25	200	500	85	38			36	16		10	.5	4.5	1	Low Speed Computer
GT-88	PNP	125	25	200	500	85	80			42	16		10				Low Speed Computer
GT-122	PNP	125	25	200	500	85	80			42	16		10	1.5	4.5	1	Low Speed Computer
2N311†	PNP	100	15	‡		−55 to +85		IC=10ma VCE=5V	25-75			VCB=15V	<60				Low Speed Computer
GT-758†	PNP	100	>20	200	500	−55 to +85	15			20φ	16	VCB=15V	< 5	<.5	4.5	1	Low Speed Computer
GT-123†	PNP	100	>20	200	500	−55 to +85	30-150					VCB=20V	< 6	> 5	4.5	1	High Speed Computer
GT-153†	PNP	100	>30	200	500	−55 to +85	> 20					VCB=20V	< 5				High Speed Computer
GT-269†	PNP	100	25	200	500	−55 to +85						VCB=12V	< 4	> 4	4.5	1	High Speed Computer
GT-759†	PNP	100	>20	200	500	−55 to +85	20			24φ	16	VCB=15V	< 5	.5 to 3	4.5	1	High Speed Computer
GT-760	PNP	100	15	50		−55 to +85	40			28φ	16		1	5	4.5	1	High Speed Computer
GT-761	PNP	100	15	50		−55 to +85	75			32φ	16		1	10	4.5	1	High Speed Computer
GT-762	PNP	100	6	50		−55 to +85	100			34φ	16		1	20	4.5	1	High Speed Computer
GT-763	PNP	100	6	50		−55 to +85	120			35φ	16		1	30	4.5	1	High Speed Computer
GT-764†	PNP	100	>20	200	500	−55 to +85	200				16	VCB=15V	< 5	> 25	4.5	1	High Speed Computer
2N43A	PNP	150	45	50		−55 to +85	32-65			>12	<20	VCB=45V	16	>.4	5	1	Military-Type
2N44	PNP	150	45	50		−55 to +85	16-32			34-43	<33	VCB=45V	15	>.4	5	1	Military-Type
2N315	PNP	100	20	200	500	−55 to +85		IC=100ma VCE=.2V	20			VCB=5V	1	5	5	1	Switching computer
2N316	PNP	100	20	200	500	−55 to +85		IC=200ma VCE=.2V	30			VCB=5V	1	12	5	1	Switching computer
2N317	PNP	100	20	200	500	−55 to +85		IC=400ma VCE=.2V	30			VCB=5V	1	20	5	1	Switching computer
2N356	NPN	100	>30	200	500	−55 to +85		IC=100ma VCE=.25V	30			VCB=5V	< 5	3	5	1	Switching computer
2N357	NPN	100	>30	200	500	−55 to +85		IC=200ma VCE=.25V	30			VCB=5V	< 5	6	5	1	Switching computer
2N358	NPN	100	>30	200	500	−55 to +85		IC=300ma VCE=.25V	30			VCB=5V	< 5	9	5	1	Switching computer
2N318/(GT-66)	PNP	50	12	20		85	100			42	20		10		4.5	1	Phototransistor
GT-34HV	PNP	150	50	‡		85	10			32	16		10		4.5	1	High Voltage
GT-34N†	PNP	125	100	200	500	85	18					VCB=100V	<450		4.5	1	Neon light
GT-34S†	PNP	125	40	200	500	−55 to +85	15			32	24	VCB=15V	15		4.5	1	Bi-directional
GT-35/(2n35)†	NPN	100	25	100	200	−40 to +75	40			40	16	VCB=12V	12		5	1	Audio, Gen. purpose
GT-229†	NPN	100	>10	200	500	−55 to +85	> 10				30	VCB=10V	<10		5	1	Experimental Amateur
GT-167†	NPN	100	25	200	500	85	> 25					VCB=15V	<10	> 5	5	1	High speed switching computer
2N312†	NPN	100	15	‡		−55 to +85		IC=10ma VCE=5V	25-75			VCB=15V	<60				High medium speed switching computer
GT-792†	NPN	100	20	100	200	−55 to +85		IC=5ma VCE=5V	37-160			VCB=5V	6	4.8	5	3	Switching computer
GT-903†	NPN	100	20	200	500	−55 to +85		IB=1ma VCE=.2V	35-70			VCB=20V	<25				High & med. speed switching computer
GT-904†	NPN	100	20	200	500	−40 to +75		IB=1ma VCE=.2V	>30			VCB=20V	<25	> 4	5	1	High speed switching computer
GT-905†	NPN	100	20	200	500	−55 to +85		IB=1ma VCE=.2V	20-40			VCB=20V	<25				High & med. speed switching computer
GT-947†	NPN	100	15	200	500	−55 to +85		IB=1ma VCE=.2V	>40			VCB=10V	<25				High & med. speed switching computer
GT-948†	NPN	100	20	200	500	−55 to +85		IB=1ma VCE=3.5V	>30			VCB=20V	<20	> 4	5	3	High & med. speed switching computer
GT-949†	NPN	100	30	200	500	−55 to +85		IB=1ma VCE=3.5V	>30			VCB=30V	<25	>.7	5	3	High & med. speed switching computer

*Supplied with Heat Sink ‡Limited only by Collector Dissipation φFrequency = 455KC †Preliminary Specifications — Subject to Revision at any Time by General Transistor Corp.

For More Complete Information on any of the Above Types, Write for Particular Specification Sheet

For more information circle **14** on inquiry card.

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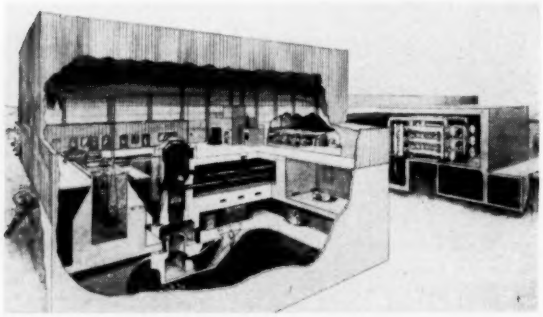
GENERAL TRANSISTOR CORPORATION

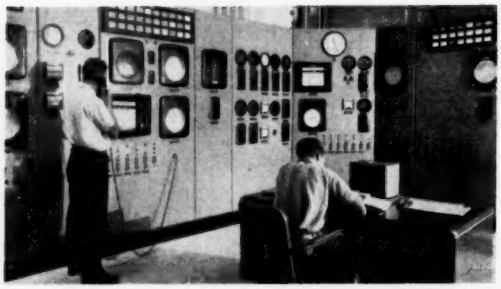
News

ETR—A Nuclear Breakthrough

Road Show Features Air-to-Ground TV

IDAHO FALLS, IDAHO—The Engineering Test Reactor—the world's most powerful instrument for the development of nuclear power—achieved criticality in Sept. 1957. Completion of the $14-million facility, newest member of the family of reactors at the vast National Reactor Testing Station, is considered a major breakthrough in the AEC's program to advance construction





of nuclear power plants for civilian and industrial use, and to convert aircraft and ships to nuclear propulsion.

The engineering Test Reactor was pioneered by the adjacent Materials Testing Reactor, which has been in operation for five years. The ETR will be used principally to determine the effects of intense neutron and gamma ray bombardment, or "radiation damage," on engineered components and materials under conditions to be met in nuclear power plants of the future.

The ETR brings into operation the highest neutron flux—approximately double that of any other reactor in the world—available for the testing of materials. This neutron flux, or rate of flow, created by the fissioning of enriched uranium placed within the core of the ETR, will average two-million billion neutrons per square centimeter per second. The fissioning process will create heat at the rate of 600-million BTU's per hour, more than four times the fission heat of any other test reactor. Leeds & Northrup supplied the instrumentation and control system. The control room (see illustration) features instrumentation by Minneapolis-Honeywell, Foxboro and Panellit.

PITTSBURGH, PA.—An innovation among engineering representatives and manufacturers is a ground-air show at which GENERAL PRECISION LABORATORY INC. and M. P. ODELL CO. have joined forces to present an exhibition of all of GPL's closed-circuit TV products. The show will visit Cincinnati, Dayton, Cleveland, Detroit, and Pittsburgh, and will occupy two days, in two phases. The first will be the groud phase; the second, the air phase using a closed-circuit TV airplane.

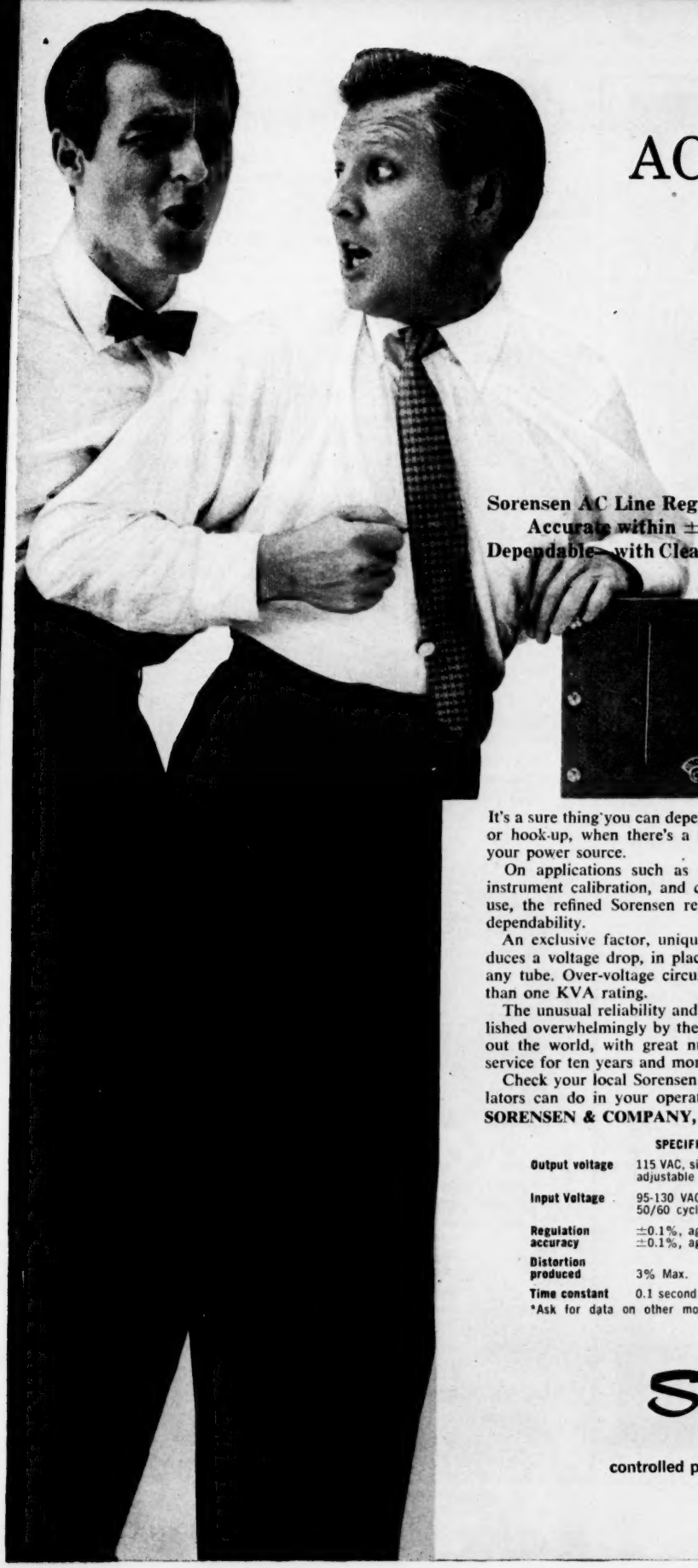
CONSOLIDATED ELECTRODYNAMICS CORP. will exhibit the latest developments in electronic instrumentation, housed in a 17-ton truck-trailer, to industrial plants

and aircraft installations in the United States and Canada. Featured is a magnetic tape recorder/reproducer system (similar to the equipment developed for the Air Force) which receives telemetered data from guided missiles in flight and plays it back for evaluation by test engineers. Also shown are high-temperature oscillograph, shock-tester, transducers, etc.

Nat'l Conference on Weights and Measures

WASHINGTON, D. C.—The 42nd National Conference on Weights and Measures was held in Washington, D. C., during the week of June 3, with approximately 450 delegates from 38 states, Alaska and Puerto Rico attending. Opening addresses were made by the Hon. Walter Williams, Undersecretary of Commerce, Dr. A. V. Astin, Director National Bureau of Standards, and the Hon. Daniel J. Carey, Commissioner of Agricul-

Circle 15 on inquiry card



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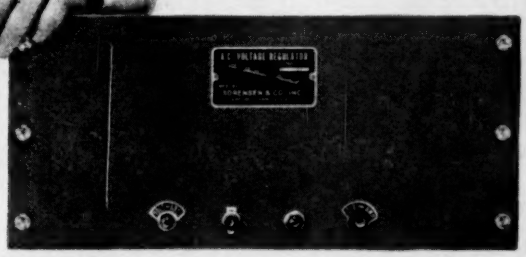
Sorensen AC Line Regulators Handle 150 VA to 15 KVA; Accurate within ±0.1% against Line or Load. Highly Dependable—with Clean Wave Form and Frequency Insensitivity.



It's a sure thing you can depend on a sustained steady voltage level, in circuit or hook-up, when there's a Sorensen AC Line Voltage Regulator cut into your power source.

On applications such as communications equipment, appliance testing, instrument calibration, and color photography—and for general laboratory use, the refined Sorensen regulating circuit gives unequaled accuracy and dependability.

An exclusive factor, unique and effective, is the safety diode which produces a voltage drop, in place of a surge, when there's a filament break in any tube. Over-voltage circuit breakers are also included in units of more than one KVA rating.

The unusual reliability and acceptance of these voltage regulators is established overwhelmingly by the thousands of installations using them throughout the world, with great numbers of these Sorensen units in continuous service for ten years and more.

Check your local Sorensen representative on what these line voltage regulators can do in your operations. Or, for technical data, write directly to **SORENSEN & COMPANY, Inc.,** *Richards Avenue, South Norwalk, Conn.*

SPECIFICATIONS Model 1000 S* (illustrated)

Output voltage	115 VAC, single phase, adjustable 110-120 volts	**Power factor range**	From unity to 0.7% lagging
Input Voltage	95-130 VAC, single phase, 50/60 cycles, ±10%	**Load range**	0 to full
Regulation accuracy	±0.1%, against line; ±0.1%, against load	**Width**	17¼"
Distortion produced	3% Max.	**Height**	8¼"
Time constant	0.1 second	**Depth**	11"
		Rack mount height	8¼"
		Net weight	75 lbs.
		Shipping weight	87 lbs.

*Ask for data on other models and capacities.

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controlled power for research and industry

NO matter how perfect otherwise, the human organism isn't much good without a dependable heart. The same is true of your automatic temperature and pH control instruments.

The "heart" of most such instruments for the past quarter century has been the Eplab Standard Cell. It is a "yardstick" for translation of voltage to temperature or pH. The first American commercial cell of its type, constantly improved by research, it is "as standard as sterling".

Get ACCURATE temperature or pH control with potentiometers and make sure the standard cells are EPLAB.

The Eppley Laboratory, Inc. 2 Sheffield Ave., Newport, R. I.

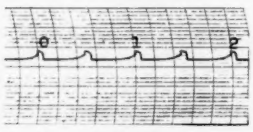
EPLAB *Standard* CELLS
FOR POTENTIOMETRIC INSTRUMENTS
"As Standard as Sterling"

For more information circle **16** on inquiry card.

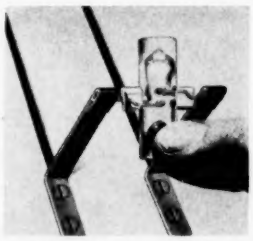
ture and Markets of the State of New York. One of the highlights of this year's proceedings was the adoption of a Statement of Organization and Procedure, which is based on the experience of the preceding 41 meetings. Copies are available on request to the Office of Weights and Measures, National Bureau of Standards, Washington 25. Dr. C. J. P. McBride was elected chairman for the ensuing year.

Switch Takes Own Picture

HARVARD, MASS.—The application of a novel pulse switch and a new standard of mounting flashing lights without destroying them has been developed by Tensitron Inc. The deflection of a Saxl Mercury Pulse Switch



Timing record of Saxl pulse switch. Pip-to-pip distance one half second. Pulse length about 75 milliseconds.



actuates a photo-flood light. Fastened to supporting springs, manual deflection causes mercury to run between two electrodes for temporary contacting, thus initiating the flash exposing the picture. An incandescent lamp can be used instead of flash guns using expendable flash bulbs.

News Bits

CENTURY ENGINEERS, INC. has designed a new rocket sled, capable of speeds up to 1000 mph to meet the increasing demand at Edwards Air Force Base Supersonic Track Facility.

Century's rocket sled capable of 1000 mph.

SCHUTTE and KOERTING have developed a new inexpensive high-vacuum system which can attain up to 5-mm Hg absolute pressure by means of recirculating chilled water through a water jet exhauster.

NBS announces that viscometer calibration by the Bureau will be discontinued effective January 1, 1958 as most companies can now do their own calibrating with standards available from NBS, the American Petroleum Institute, or elsewhere.

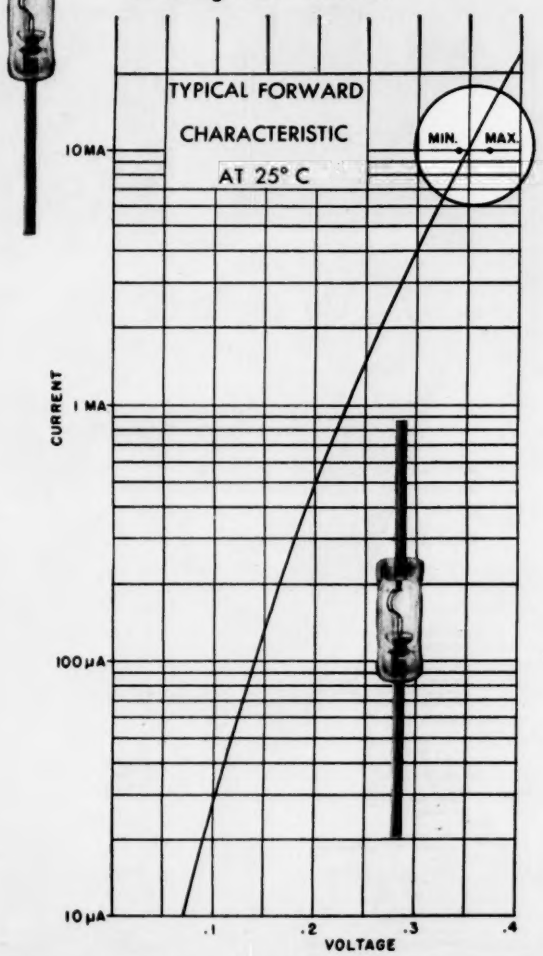
PERKIN-ELMER CORP. has designed and built a 12" astronomical telescope which was carried to heights of 80,000 ft by a "Skyhook" polyethylene ballon to bring the sun closer to the camera. Some 8000 pictures were taken to study the turbulence on the sun's surface.

for circuits requiring utmost voltage economy

GOLD BONDED

Radio Receptor Germanium Diodes

10MA forward current with a maximum loss of only .37 volts!



DR 385	DR 434	DR 435

This extremely low controlled forward voltage drop combined with fast transient response makes these diodes ideal for transistorized circuits, computers and other applications where conservation of power is of prime importance.

Characteristics at 25° C

	DR 385	DR 434	DR 435
Forward voltage drop @ 10MA			
Minimum	0.34V	0.34V	0.34V
Maximum	0.37V	0.37V	0.37V
Maximum reverse current at −10V	10UA	10UA	10UA
Peak inverse voltage	60V	40V	30V

Maximum ratings at 25° C

Maximum inverse operating voltage	50V	30V	20V
Continuous DC forward current	100MA	100MA	100MA
Surge current for 1 second	500MA	500MA	500MA
Average power dissipation	80MW	80MW	80MW
Derating above 25° C	10MW/10°C	10MW/10°C	10MW/10°C

Available now in production quantities for immediate delivery

For further information on these, or any other RRco. diode type, write today to Section

Semiconductor Division

RADIO RECEPTOR COMPANY, INC.

Subsidiary of General Instrument Corporation

240 Wythe Avenue, Brooklyn 11, N. Y. • EVergreen 8-6000

Radio Receptor Products for Industry and Government: Selenium Rectifiers • Germanium Diodes Thermatron Dielectric Heating Generators & Presses • Communications, Radar & Navigation Equipment

RADIO & ELECTRONIC

RR

PRODUCTS SINCE 1922

For more information circle **17** on inquiry card.

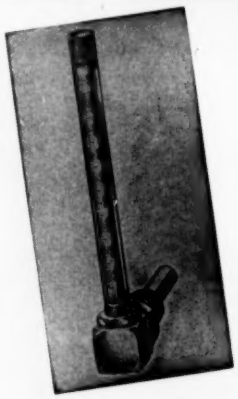
Standardize on Easy-to-Read

YEL ⊖ BAK

Reg. U. S. Pat. Office

FLAT BORE ENGRAVED STEM

MIDGET INDUSTRIAL THERMOMETERS



★ **ACCURATE**—to within a fraction of a degree

★ **EASY - TO - READ**—broad — flat stripe — mercury column in a yellow stem

★ **ECONOMICAL**—replacement can be inserted on-the-job without difficulty

★ **ARMOUR PROTECTED**—to resist corrosion and dirt

★ **TWO TYPES**—angle and straight stem

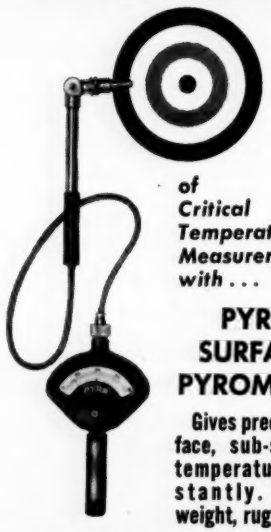
ASICO
Reg. U. S. Pat. Off.

Write for **CATALOG 25**

ACCURACY SCIENTIFIC INSTRUMENT CO.
2903 N. 12th STREET
PHILADELPHIA 33, PA.

For more information circle **18** on inquiry card.

UNEXCELLED ACCURACY



of Critical Temperature Measurements with . . .

PYRO SURFACE PYROMETER

Gives precise surface, sub-surface temperatures instantly. Lightweight, rugged.

Send for FREE catalog No. 168.

PYROMETER INSTRUMENT CO., INC.
BERGENFIELD 4, NEW JERSEY

For more information circle **40** on inquiry card.

NEWS—CONTINUED

SHEFFIELD CORP., a subsidiary of Bendix Aviation Corp., has received the first two Krypton 84 atomic isotope tubes for its Eli Whitney Metrology Lab. Developed by Germany's Physikalisch-Technische Bundesanstalt the tubes create light sources of the utmost known precision and purity.

GENERAL ELECTRIC has developed a new "hi-fi" simple, color tube, called the "Penetron" for specialized TV applications.

ASKANIA REGULATOR CO. hosted a Japanese Instrument Specialist Study team, headed by Professor Ziro Yamauti, University of Tokyo. The group is studying American methods of automation.

Japanese Instrumentation Specialists visit Askania (left) and Minneapolis-Honeywell (right).

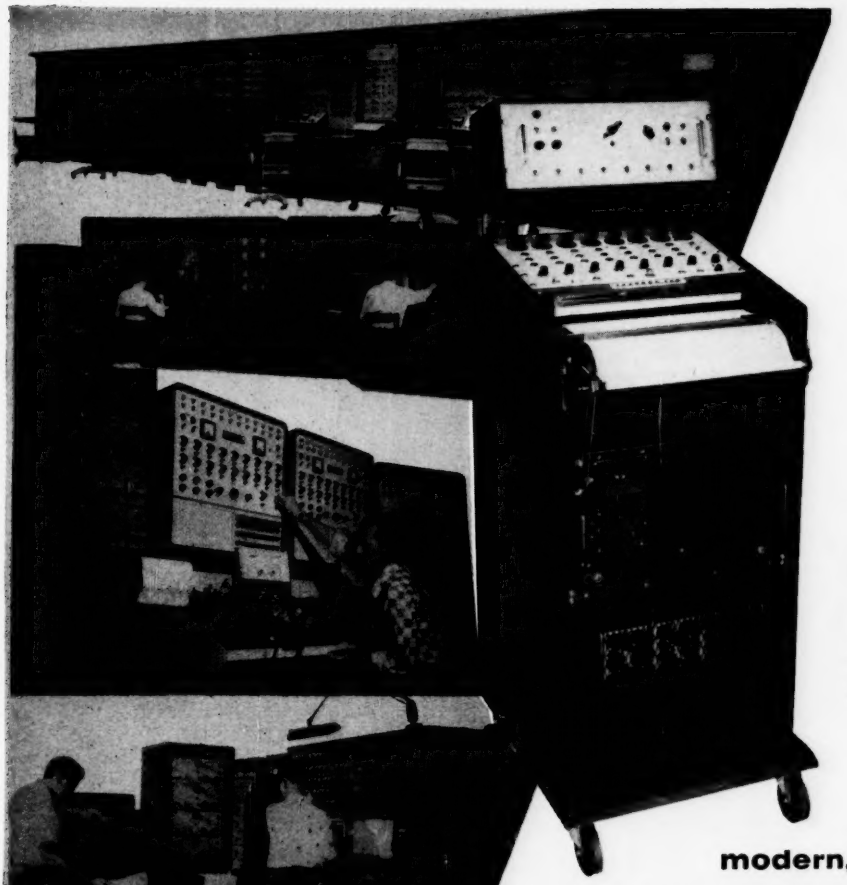
The same group stopped at Philadelphia at **BROWN INSTRUMENTS DIV.** of Minneapolis-Honeywell and is shown in picture paying close attention to the testing of an electronic recorder.

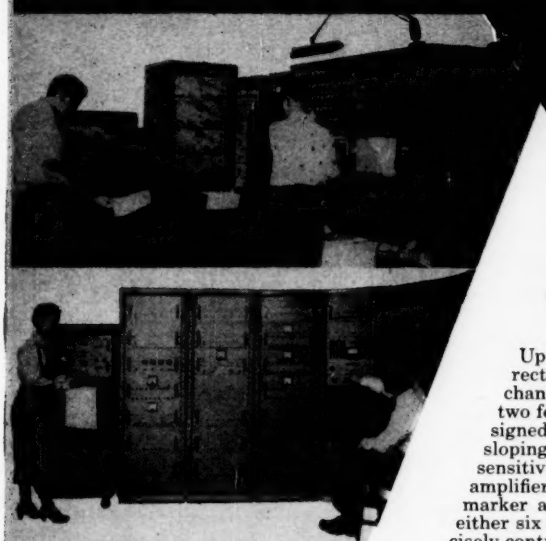
Stock Report

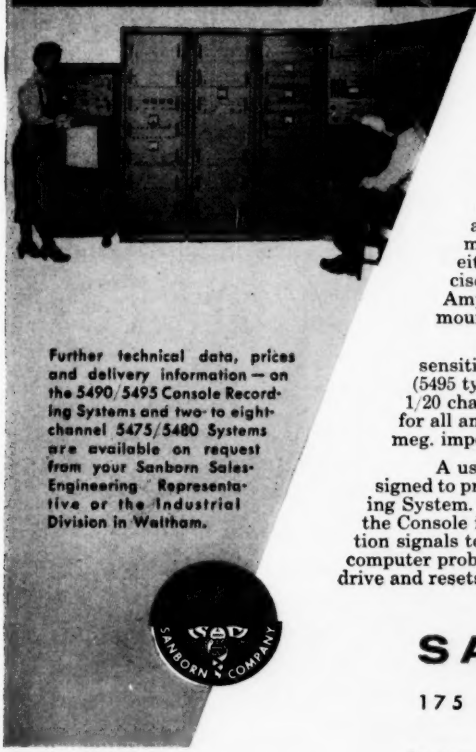
Any further information concerning any of the following issues may be obtained from the Research Department, Bache & Co., 36 Wall Street, New York 5, N. Y.

New York Stock Exchange:

	Price Range For 1957 Thru 9/17		Price As Of 9/17
	High	Low	
ACF Industries	64 7/8	53 1/2	54 1/4
Aeroquip Corp.	31 3/8	20 1/8	25 1/2
Allis Chalmers	36 1/4	31 1/8	31 1/8
American Chain & Cable	64 1/4	48 3/4	50 3/8
American Machine & Foundry	43 3/4	31 5/8	38 1/8
American Machine & Metals	58 3/4	41	56 1/4
American Optical	37 7/8	33	33 3/4
American Tel. & Tel.	179 7/8	170 1/2	171 1/8
Beckman Instruments	47 3/4	34 1/2	35 1/2
Bell & Howell	50 1/2	38 1/2	45 1/8
Bendix Aviation	66 3/4	50 1/8	52
Boeing Airplane	61 1/8	36 3/8	40 5/8
Bullard	29 1/8	14 1/2	14 3/4
Bulova Watch	21	16 1/8	16 1/4
Burroughs	52 3/8	33 7/8	40 1/8
Cartorundum	51 1/4	38 3/4	41 5/8
Cincinnati Milling Machine	50 1/2	35 7/8	36 3/4
Clevite	25 1/2	18	22 7/8
Columbia Broadcasting 'A'	36 1/8	27 5/8	29
Consolidated Electronics	35 1/2	26 3/8	27 3/8
Cornell Dubilier	27 1/2	18 1/4	19 3/4
Corning Glass	106 1/4	57 1/4	88 5/8
Curtiss-Wright	47 3/8	35 5/8	36
Cutler Hammer	64 3/4	47 3/4	49
Consolidated Electrodynamics	54 3/4	31 1/4	42
Daystrom	47	29 5/8	41 5/8
Douglas Aircraft	91	63 1/2	65 3/4
Eastman Kodak	115	81 3/4	95 1/2
Eaton Manufacturing	64 1/4	45 3/4	48
Electric Auto Lite	40 3/8	30 1/4	36 1/4
Elgin Watch	14 1/8	9 5/8	10
Emerson Electric	34	26 1/4	26 1/4 - 26 7/8 (1)
Food Machinery & Chemical	65 1/4	50 1/8	50 1/2
Gamewell	36 1/2	27 1/8	27 1/8 - 27 1/4 (2)
Garrett	54	34 3/4	36
General Dynamics	68 5/8	52 1/8	54 7/8
General Electric	72 3/8	52 3/8	63 1/2
General Instrument	8 1/8	5 7/8	6
General Mills	69	57 7/8	62 1/2
General Precision Equipment	47 1/4	36 1/2	40 3/4
General Railway Signal	34	27	28 3/4
General Telephone	45 1/4	38 3/4	40 1/4
General Time	30 1/2	20 1/4	20 1/4
General Tire & Rubber	98 1/2	55 1/4	80 3/8







for analog computer readout:

modern, compact, mobile

SANBORN

CONSOLE RECORDING SYSTEMS

Up to eight problem variables can be recorded in inkless, permanent, rectangular-coordinate tracings – with Sanborn's improved six- and eight-channel 156-, 158-5490 Console Systems. Less than four feet high and about two feet in width and depth, these Systems are completely mobile and designed for maximum operating convenience. Controls and indicators on the sloping top panel include individual-channel attenuation, position, balance, sensitivity and stylus heat adjustments; switch for turning off B+ of output amplifiers; chart drive motor switch (can also be remotely controlled); code marker and/or one-second interval timer stylus switch. The Recorder unit, either six or eight channels, features paper loading from the top, and nine precisely controlled speeds from 0.25 to 100 mm/sec. Four dual-channel DC Driver Amplifiers of current feedback design are housed below the Recorder, and are mounted on a chassis which may be withdrawn for inspection.

Electrical specifications of the Console Recording Systems include a basic sensitivity of either .01 volt/chart division (5490 types) or 0.1 volt/chart division (5495 types); linearity of 1%; drift less than 1/2 chart division/hour (5490), less than 1/20 chart division/hour (5495); flat frequency response to 20 cps, down 3 db at 60 cps for all amplitudes to 5 cm peak; either single-ended or push-pull input signals of 5 meg. impedance (each input lead to ground).

A useful companion instrument is the new Sanborn Model 183 Programmer, designed to provide a connecting link between an analog computer and the Console Recording System. Shown mounted at the top rear of the Console, the Programmer operates the Console in the following automatic sequence: turns recorder drive on – feeds calibration signals to all channels – reads initial DC levels of computer – closes contacts to start computer problem – records computer output for a preset chart length – turns off recorder drive and resets itself for another cycle.

Further technical data, prices and delivery information – on the 5490/5495 Console Recording Systems and two- to eight-channel 5475/5480 Systems are available on request from your Sanborn Sales-Engineering Representative or the Industrial Division in Waltham.

SANBORN COMPANY
INDUSTRIAL DIVISION
175 Wyman Street, Waltham 54, Massachusetts

For more information circle **19** on inquiry card.

Kipfel GOLDEN GENIE Self-Operating TEMPERATURE REGULATOR

- Overheat Protection
- Indestructible Yoke
- Direct or Reverse Acting
- Single, Double or Three Way Bodies
- Wide Temperature Range

NEW Process Product Profit FLOW INSURANCE!

Install it—*forget it!* Yes, this new completely self-operating temperature regulator is equipped with a rugged 2-ply (double wall) seamless bellows to *insure* long, dependable valve actuation and prevent overheating and spoilage of products . . . damage to process equipment . . . expensive down-time. In an emergency, an exclusive over-ride control (optional) permits manual operation.

Built for dependable service, rugged cup type seamless 2-ply Hellows, develops more power.

New Golden Genie offers many years' ahead features for increased efficiency and economy. Write us—we'll send the proof!

Kipfel VALVES, INC., Div. of Hamilton-Thomas Corp.
Dept. D-10 Hamilton, Ohio
Export Dept., 1010 Scheff Bldg., Philadelphia

For more information circle **20** on inquiry card.

New York Stock Exchange:

Continued from page 1838

International Business Machines	376 1/2	288	314
International Tel. & Tel.	37 3/4	29 1/2	31 5/8
Lockheed Aircraft	57 1/8	32 5/8	35 3/4
Litton Industries	56 5/8	29 1/2	45
Magnavox	44	34	38
Minneapolis-Honeywell	131	73 1/2	93 3/4
Minnesota Mining & Mfg.	101	58	89 3/8
Motorola	51 3/4	35 3/4	47 1/4
Mallory, P. R.	50 1/4	34 3/4	35 3/4
National Acme	80 1/2	55	54 - 55 (1)
National Cash Register	70 5/8	46 1/4	59 3/4
North American Aviation	39 1/4	21 3/4	25
Northrop Aircraft	28 1/8	21 1/4	23
Otis Elevator	49 1/2	39 1/8	46 1/4
Philco	18 3/8	14	14 1/4
Radio Corp. of America	40	31 5/8	33 1/2
Raytheon	23 3/4	16 3/8	21 5/8
Rheem Manufacturing	21 1/4	15	15 1/8
Robertshaw Fulton	36 1/2	25 5/8	32 1/8
Reliance Electric	50 7/8	36	41
Sangamo Electric	39 3/4	31 1/4	34 1/2 - 35 1/4 (2)
Sperry Rand	26 1/8	20	21
Square D	35 3/4	27	26 1/2
Standard Coil Products	9 3/8	6 1/2	7 3/8
Starrett (L.S.)	85 1/2	62 1/2	69
Stewart-Warner	41 5/8	31 7/8	36 1/2
Sylvania Electric	46 1/4	34	37
TelAutograph	8 3/4	5	5 5/8
Texas Instruments	31 1/2	15 7/8	27 5/8
Thompson Products	89 3/4	62 1/4	64
Tung-Sol Electric	37 1/2	27 3/8	31 1/4
Underwood Corp.	33 3/4	22 1/2	22 7/8
Union Carbide & Carbon	124 1/2	100 5/8	110 1/4
United Shoe Machinery	45 7/8	37	38 1/2
Western Union	20 3/8	17 5/8	17 7/8
Westinghouse Air Brake	33 1/8	25 1/2	26 1/4
Westinghouse Electric	68 5/8	52 3/8	63 1/4
Worthington Corp.	68 3/8	52 1/4	54 3/4

(1) Not traded - Bid - Asked
(2) Not traded - Bid - Asked

American Stock Exchange:

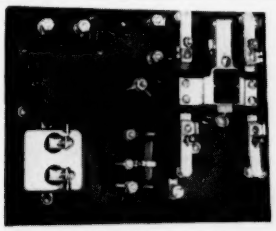
	Price Range For 1957 Thru 9/17		
	High	Low	Price As Of 9/17
American Meter	34 1/8	27 1/2	30 1/2
Aero Equipment	22 7/8	16 1/4	17 3/8
Belock Instrument	13 5/8	9	11
Benrus Watch	8 1/2	6 7/8	7 1/2
Breeze Corp.	8 3/8	5 3/4	6 3/4
Barry Controls "B"	12 3/4	7 1/2	7 - 7 1/2 (1)
Clark Controller	31	21 1/2	21 1/8
Clarostat Mfg.	5	3 3/8	4
Clary Corp.	4 7/8	4	4 1/8
DuMont Laboratories	6 1/8	4 1/8	4 1/2
Dynamics Corp. of America	7 5/8	3 1/2	4
Electronics Corp. of America	12 7/8	8	9 1/4
El-Tronics	3 7/8	2 1/8	2 1/2
Fairchild Camera & Instrument	27 3/8	16	24 1/2
Globe Union	20 3/4	16 5/8	18 3/4 - 19 3/8 (2)
Hazeltine Corp.	44 1/2	29 3/4	36 1/2
International Resistance	6 1/8	4 3/4	4 7/8
Lear Inc.	8 3/4	5	5 5/8
National Research	26 5/8	16 1/4	17 1/2
Neptune Meter	33 1/2	27 1/4	28 1/8
New Haven Clock	9/16	1/4	1/4 - 5/16 (3)
Norden-Ketay	11 3/4	7 7/8	8 1/2
Nuclear Corp. of America 'A'	2 1/4	3/4	1 1/2
Pneumatic Scale	25	21 1/2	20 1/2 - 21 1/2 (4)
Servo Corp. of America	8	4 5/8	6 1/4
Servomechanisms	12 5/8	8 1/2	8 3/4
Wallace & Tiernan	33 7/8	25 7/8	30 3/4
Waltham Watch	2 1/4	1 3/8	1 3/8

1(Not Traded - Bid-Asked
2(" " " "
3(" " " "
4(" " " "

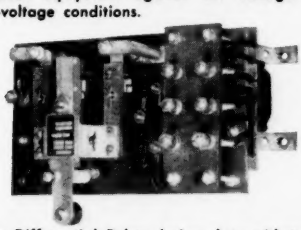
Over-The-Counter

	Quotation As Of 9/17	
	Bid	Asked
Aerovox Corp.	4 5/8	5 1/4
Aircraft Radio Corp.	21 3/4	22 3/4
Argus Corp.	17 3/4	18 1/2
Eitel-McCullough Co.	30	31 1/2
Electronics Associates	40 1/2	43
Elox Corp. of Michigan	10	10 5/8
Erie Resistor Corp.	10	10 5/8
G. M. Giannini	13 1/2	14 3/4
Liquidometer Corp.	5 3/4	6 1/2
W. L. Maxson	6	6 1/2
Penn Controls, Inc.	16	17
Speer Carbon, Inc.	26	27 3/4
Sprague Electric	30 1/4	31 1/4
Taylor Instrument	35 1/4	36 1/2
Telecomputing Corp.	3 3/4	4 1/8
Topp Industries	12 3/4	13 1/8
Varian Associates	18 5/8	19 1/8
Vitro Corp. of America	23 3/4	24 1/2

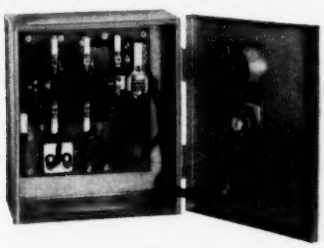
ASCO close differential relays respond crisply to 2% voltage or current variations... with no chattering on pickup or dropout.



Voltage Type Close Differential Relay protects electrical equipment against low voltage or over-voltage conditions.



Close Differential Relay designed to withstand NAVY Hi-shock requirements. Has tapped transformer making the relay suitable for a series of different pickup and dropout voltages.



Current type Close Differential Relay Panel for process control. (Relay operates as a function of motor load current.) Has adjustable pickup and dropout control. Panel has been used successfully for controlling cotton baling equipment.

ASCO Close Differential Relays (available either A-C or D-C) have been developed to meet the demand for a unit having the ruggedness of a power relay yet retaining the sensitivity of a primary control relay.

FEATURES

• Positive action on make or break, with no tendency to creep on opening or closing • 2% Sensitivity • Wide Variety of Applications • Available in Various Pole Combinations Up To 2 Normally Open and 2 Normally Closed Poles • Continuously Adjustable Pickup, or Variable Pickup By Tap Changing is Available • Continuous Dropout Adjustment is Standard.

MODIFIED ARRANGEMENTS

• High Shock Design • Variable Pickup • Frequency Response • Delayed Action • D-C Relays Also Available.

APPLICATIONS

As Voltage Relays they are extensively used in power and lighting systems to protect electrical equipment against low voltage or over-voltage conditions. For example... they permit detection where motor feedback conditions would not permit detection by ordinary potential relays. These relays are regularly furnished with ASCO Transfer Switches to provide voltage supervision of single phase and polyphase systems.

As Current Relays they have found extensive application as off-peak load relays to automatically disconnect selected loads, preventing system loading beyond set values. Close differential detection makes ASCO Close Differential Relays ideal for process control by motor current measurements.

Close Differential Relays are only part of the complete line of Relays offered by ASCO. ASCO Catalog 57-S4 lists:

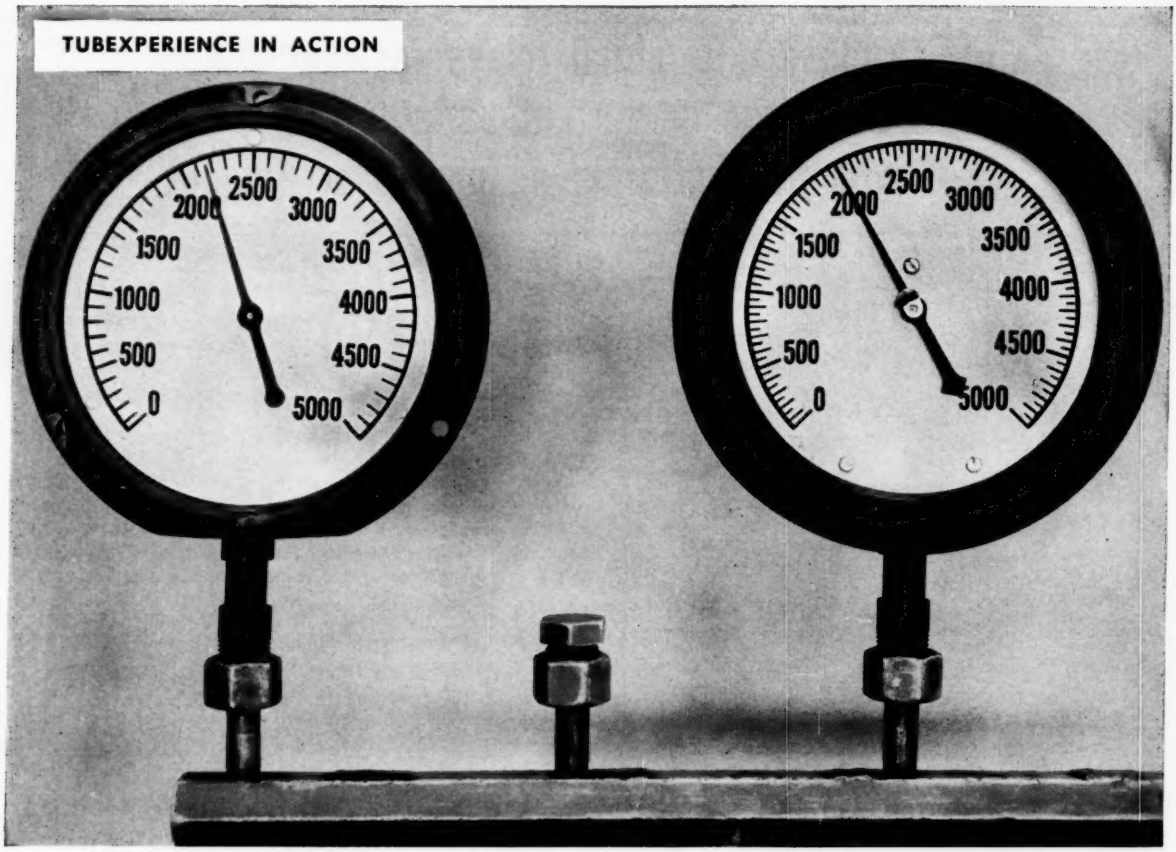
- **MAGNETICALLY HELD RELAYS**
  AC or DC . . . Normally Open . . . Normally Closed . . . Double Throw
- **MECHANICALLY HELD RELAYS**
  AC or DC . . . All pole combinations
- **SPECIALIZED RELAYS, INCLUDING:**
  - . . . Reverse Current
  - . . . Time Delay
  - . . . Brake Winding Time Delay
  - . . . Close Differential
  - . . . Current Type, Welding
  - . . . Electronic
  - . . . Modified Arrangements

Write for your copy of "Relays by ASCO"— Catalog 57-S4.

Automatic Switch Co.
52-F Hanover Road, Florham Park, New Jersey
FRontier 7-4600

ASCO®

For more information circle **21** on inquiry card.



Q. Which gage tells the truth longer?

A. *The gage with the Superior extra-quality Bourdon tube*

HERE'S WHY—

Quality cannot be inspected into tubing. Thus at Superior the quality is built in from start to finish. Stock for redrawing is carefully selected and prepared. Superior's method of producing Bourdon tubing includes many special techniques, developed through years of "tubexperience." Such factors as surface quality, close dimension control, freedom from decarburization, accurate shaping and cleanliness, all combine to produce a Bourdon tube of unexcelled quality.

Cheap Bourdon tubing no economy. Why risk having your gages fail or lose their accuracy? Inferior quality Bourdon tubing will crack, develop leaks, or take a set long before Superior's will show any signs of wear.

Quality Bourdon a must. The Bourdon tube represents only a small fraction of the total cost of your gage, yet it is the most important single element. Be sure to get only the best Bourdon tubing available.

Specify Superior. There are 8 different Bourdon analyses to choose from, including Ni-Span C. Flat ovals, ellipticals, rounds and partial rounds, etc. For technical data on Superior extra-quality Bourdon tubing, write for a free reprint of "Bourdon Elements Require Special Tubing." Superior Tube Company, 1968 Germantown Ave., Norristown, Pa.

Superior Tube

The big name in small tubing

NORRISTOWN, PA.

All analyses .010 in. to ⅝ in. OD—certain analyses in light walls up to 2½ in. OD

West Coast: Pacific Tube Co., 5710 Smithway St., Los Angeles 22, Calif. • RAymond 3-1331

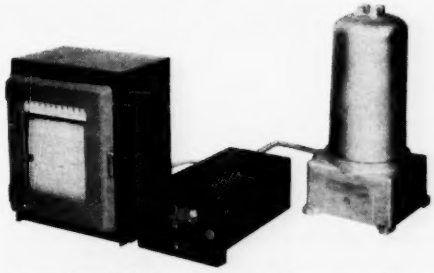
For more information circle **22** on inquiry card.

Increase "on-spec" yields for pennies a day

Reliable, low-cost quality control with CEC's

PROCESS CHROMATOGRAPH

EXAMPLE: AVIATION GASOLINE...The three most popular alkylation processes use CEC's 26-202 Process Chromatograph for continuous monitoring of aviation gasoline quality. Finger-tip control allows treatment of end-product quality as another operating parameter, frees laboratory personnel for other projects. The 26-202 is the most practical system available today for remote control and recording, automatic sampling, automatic programming of recorded data, precise regulation of temperatures and carrier flow. *Contact your nearby CEC field office, or write for Bulletin CEC 1836-X16.*



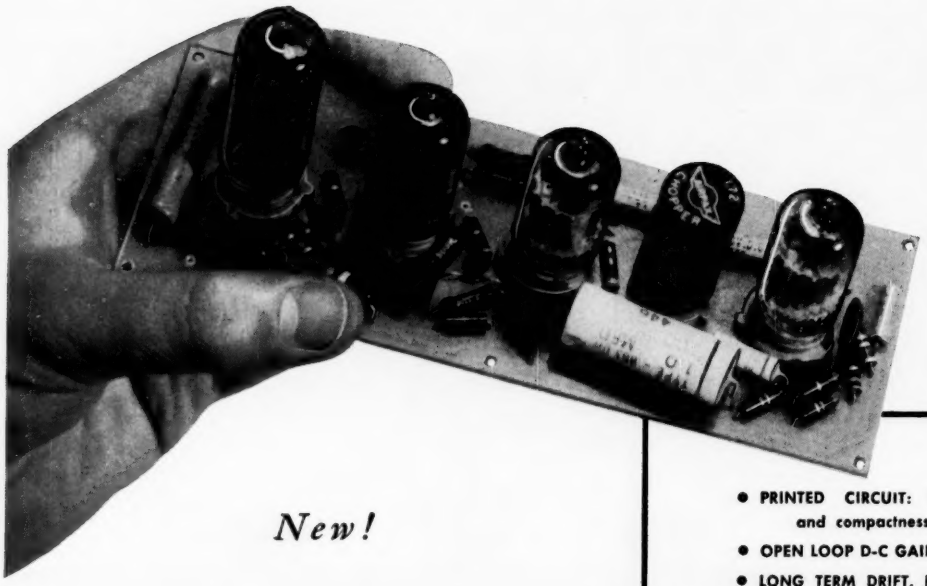
Superior reproducibility and trouble-free, *continuous* service are provided by this completely transistorized two-unit system. Analyzer unit meets specifications for installation in Class I, Group D, Division I hazardous locations. Control unit, from its remote location, provides timing and control with precise regulation.

Consolidated Electrodynamics

300 North Sierra Madre Villa, Pasadena, California

OFFICES IN PRINCIPAL CITIES THROUGHOUT THE WORLD

For more information circle **23** on inquiry card.



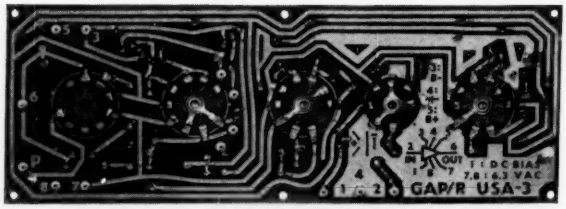
New!

Greater System Accuracy

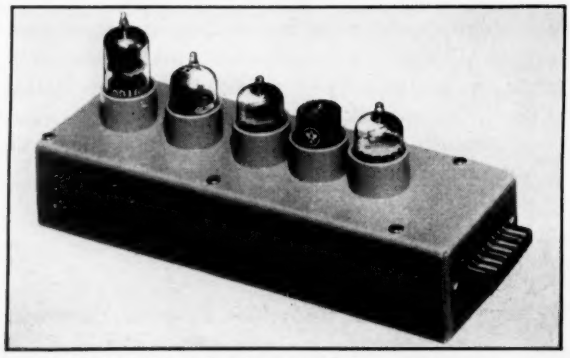
and Reliability with the

- **PRINTED CIRCUIT: Economy, reliability and compactness.**
- **OPEN LOOP D-C GAIN: 10 million.**
- **LONG TERM DRIFT, NOISE and OFFSET: under 100 microvolts.**
- **OUTPUT VOLTAGE RANGE: ±115 volts.**
- **SIZE: 7" x 2½" board.**
- **MOUNTING: Any convenient method.**
- **PRICE: $95.00.**

PHILBRICK *PRINTED CIRCUIT* AMPLIFIER



Underside of Model USA-3 showing printed circuit, amplifier connection scheme, and connecting terminals.



Model USA-3 showing one of the several types of modular packaging available at extra cost.

Model USA-3

High performance combined with the reliability and compactness of a printed circuit design are featured in the new Philbrick Universal Stabilized Amplifier, Model USA-3. It is ideally suited for applications to instrumentation, control and analog computation. Extremely high open-loop d-c gain, wide bandwidth, low noise and wide output range are important performance characteristics of this new chopper stabilized amplifier. An interesting design feature makes this instrument safe against self-destruction, even under prolonged overload conditions or direct grounding of its output. At a price of only $95.00, it offers more performance per dollar than any other amplifier on the market today. *Write to George A. Philbrick Researches, Inc., Dept. 12, for Bulletin USA-3.*

GEORGE A.
PHILBRICK
RESEARCHES, INC.
230 Congress Street, Boston 10, Massachusetts

For more information circle **24** on inquiry card.

TRINITY EQUIPMENT and **INDUSTROL CORP.** were honored by Governor Harriman's presence at the cornerstone-laying ceremonies at Cortland, N. Y. for their new 40,000-sq-ft. plant.

New Plants and Mergers

HAGAN CHEMICALS and CONTROLS, INC. announces formation of a wholly separate Nuclear Power Division. Fifteen of Hagan's top mechanical and chemical engineers are taking an intensive course in nuclear-reactor technology to which A. A. Markson, assistant vice president in charge of engineering, contributes greatly with his knowledge condensed in a new book *Atom Primer for Engineers*, soon to be published by Instruments Publishing Company.

INTERNATIONAL GLASS CORP. has approved the acquisition through merger of Cascade Research Corp., and has accepted **MONOGRAM PRECISION INDUSTRIES, INC.** as new name of corporation.

UNITED STATES GAUGE DIV., American Machine and Metals Inc., has added 180,000 sq-ft of space to its present facilities.

C. P. CLARE & CO., is constructing a new 40,000-sq-ft plant at Fairview, N. C.

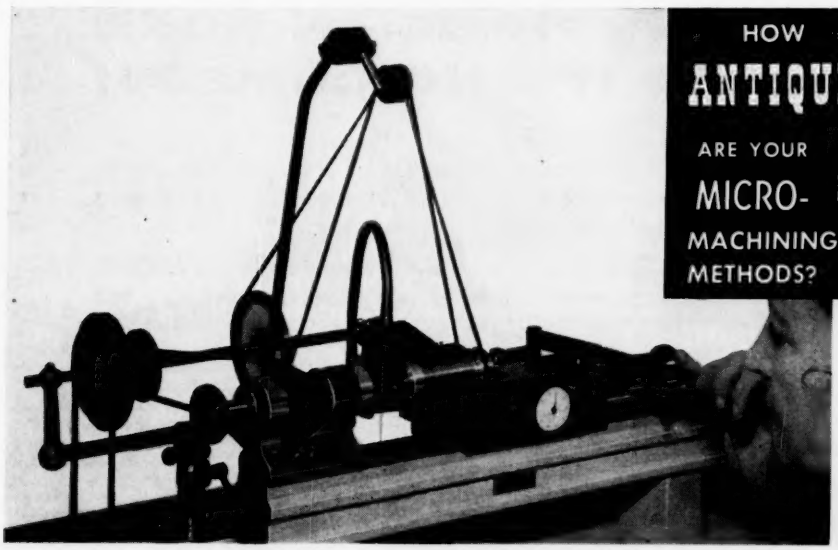
MINE SAFETY APPLIANCES CO. announces formation of Mine Safety Appliances de Mexico S. A. de C. V. in Mexico City, with C. M. Donahue as president.

VAPOR RECOVERY SYSTEMS CO. has doubled the size and facilities of its Electronic Div., and renamed it Electro-Mechanical Division.

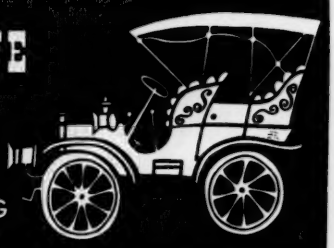
LEEDS & NORTHRUP CO. has organized a wholly owned subsidiary, Leeds & Northrup, Canada, Ltd., with J. William Robinson as president.

ESC CORP. announces the opening of a new Electronics Components Div.

MINNEAPOLIS-HONEYWELL has built a new 37,400-sq-ft plant in Fall River, Mass. for production of electronic recording and controlling instruments, and has also opened new 120,000-sq-ft valve plant at Fort Washington, Penna.



HOW ANTIQUE ARE YOUR MICRO-MACHINING METHODS?



DRILL MICRO-HOLES

DOWN TO .0016" with SPEED & ACCURACY

ON LEVIN® INSTRUMENT LATHES

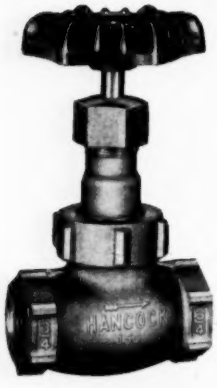
The Levin micro-drilling equipment shown here can be used with the smallest drills available. It is designed so that the drilling does not depend on the operator's sense of feel. The drill can be retracted for chip removal and returned to the drilling position without striking the bottom of the hole. While commercial drills can be had as small as .0016" this micro-drilling apparatus has successfully produced holes as small as .0006".

Send for Catalog M describing complete line of instrument lathes and accessories.

LOUIS LEVIN & SON, INC.—3610 S. BROADWAY—LOS ANGELES 7, CALIFORNIA

For more information circle **25** on inquiry card.

THIS "ACT" COSTS $10.00 AN HOUR . . . AND IT'S NO COMEDY!



Maintenance costs today make ordinary bronze valves an expensive gamble. Such valves with renewable composition seats and discs require frequent maintenance – piping systems out of service – unnecessary labor. And, the cost of a new disc is only the beginning!

You can eliminate both the expense and the problem. Use Hancock Bronze Valves with *superhard* "500 Brinell" stainless steel seats and discs. They last throughout the life of the valve – won't wire-draw, steam-cut or gall.

Be sure of highest efficiency and lowest maintenance. *Specify Hancock Bronze Valves!* Sizes range from ¼" through 2" in globe and angle types, with screwed ends – for all pressures up to 300 psi at 550° F.

PHONE YOUR INDUSTRIAL SUPPLY DISTRIBUTOR for complete information about Hancock Bronze Valves. He is always ready to give you quick service.

When Hancocks go in, valve costs go down

In Canada: *Manning, Maxwell & Moore of Canada, Ltd., Galt, Ontario*

1877 HANCOCK U.S.A.

MAXWELL MANNING & MOORE INC. TRADE MARK

HANCOCK VALVES

A product of **MANNING, MAXWELL & MOORE, INC.** Watertown 72, Massachusetts

MAKERS OF 'ASHCROFT' GAUGES, 'AMERICAN' INDUSTRIAL INSTRUMENTS, 'CONSOLIDATED' SAFETY VALVES, 'AMERICAN-MICROSEN' INDUSTRIAL ELECTRONIC INSTRUMENTS, *Stratford, Conn.* 'HANCOCK' VALVES, *Watertown, Mass.* 'CONSOLIDATED' SAFETY RELIEF VALVES, *Tulsa, Okla.* AIRCRAFT CONTROL PRODUCTS, *Danbury, Conn. and Inglewood, Calif.* "SHAW-BOX" AND 'LOAD LIFTER' CRANES, 'BUDGIT' AND 'LOAD LIFTER' HOISTS AND OTHER LIFTING SPECIALTIES, *Muskegon, Mich.*

HS-57

For more information circle **26** on inquiry card.

H. S. Gleason

R. K. Stern

R. T. Biedler

D. M. Considine

T. C. Fry

People IN THE NEWS

STROMBERG-CARLSON has appointed Howard S. Gleason as Asst. General Manager, Electronics Div.

MID-CENTURY INSTRUMATIC CORP. announces appointment of Robert K. Stern as president.

BALDWIN-LIMA-HAMILTON, Electronics and Instrumentation Div., has named Richard T. Biedler as advertising manager.

DETROIT CONTROLS CORP. has appointed Ares G. Bogosian as Director, Systems Plant at Norwood, Mass.

REPUBLIC MFG. CO. announces appointment of Lester J. Henderson as vice president in charge of sales.

REMINGTON RAND DIV. has appointed Dr. Thornton C. Fry as vice president and director Univac Engineering.

HUGHES AIRCRAFT has appointed Douglas M. Considine to director marketing for Hughes Products Group.

FEMCO INC. has promoted John W. Bauer Jr. to newly established post of sales manager.

WOLVERINE TUBE DIV. Calumet & Hecla Inc., has appointed Jack H. Smith to newly created post of Manager of Districts.

ASSOCIATED SPRING CORP. has promoted William R. Harkness to sales manager, Seaboard Pacific Div.

THOMAS A. EDISON INDUSTRIES has appointed Victor W. Rose advertising and sales promotion manager.

ACOUSTICA ASSOCIATES INC. has appointed Ralph Reynolds general sales manager.

ARNOUX CORP. announces Thomas F. Watson has joined the corporation as Senior Field Engineer.

ELECTRONICS DIV. of Clary Corp. has appointed Stuart T. Schy as technical engineer in charge of its new Eastern Engineering Office.

for every purpose

Photoelectric Controls you can depend on

Heavy Duty Industrial Quality Photoelectric Controls with gasket-sealed cast aluminum housing for—

Automatic control of tension, jam-up, registration, illumination, liquid and material level.

Automatic sorting, measuring, inspecting, weighing, counting.

Automatic die protection, smoke detection, packaging, processing, marking.

New Catalog, 24 pages, replete with application diagrams—

Describes wide range of standard photoelectric, impact and current-surge control equipment. Send for your copy—NOW.

Normal, high speed, ultra sensitive and impulse actuated photoelectric and photoelectric timing controls with Safety Relays and Warm-up protection. Dark and Light-energized. Standard and Plug-in Mountings.

Normal, miniature and high intensity light sources with straight, adjustable focus and fixed pin point focus light beams, also beam intensity adjustment.

Standard equipment to meet most requirements. Special equipment engineered for the job.

Tell us what you need or send for catalog.

AUTOTRON, INC.

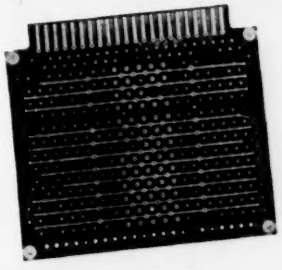
Box 722QZ Danville, Ill.

Representatives in Principal Cities

For more information circle **27** on inquiry card.

TRACER-GUIDED DRILLING
100 HOLES P. M.
WITH NEW HERMES Engravograph

for printed circuit plates

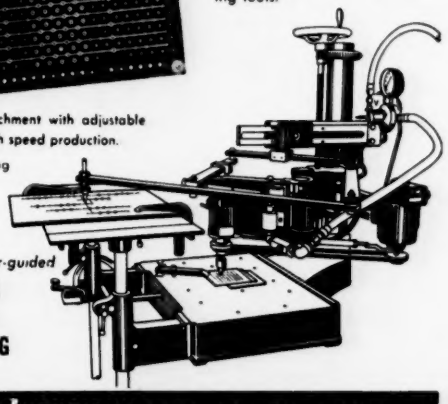


• Pantograph reproduces drill pattern from template in any reduction ratio – assuring high accuracy.

• Allows drilling and routing of different size holes in one operation without changing tools.

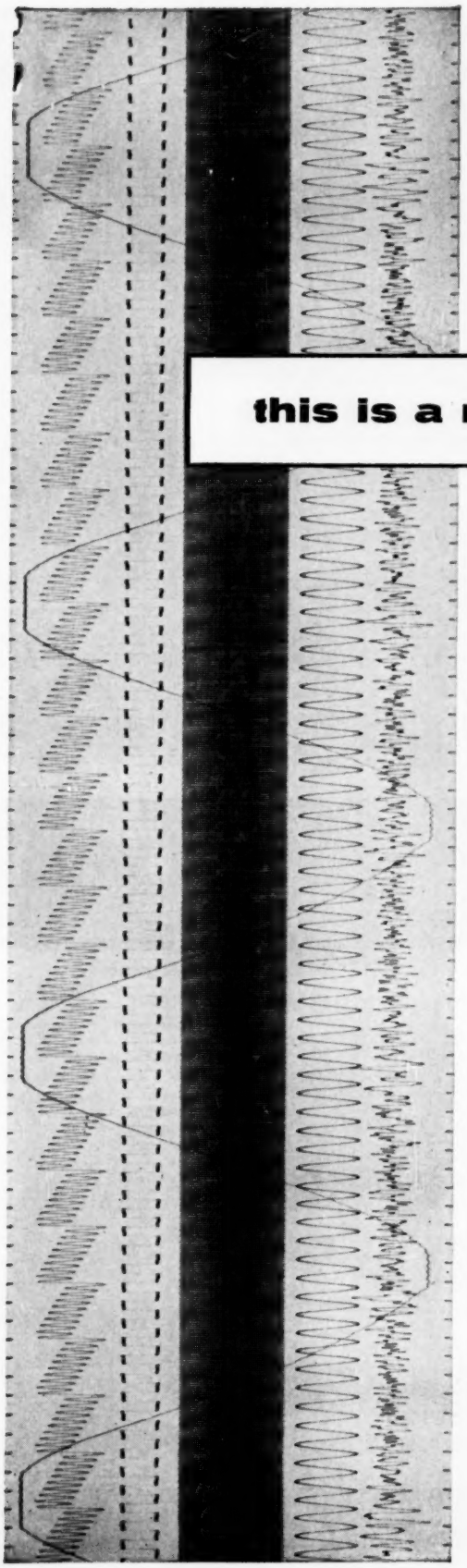
Pneumatic attachment with adjustable feed gives high speed production.

Ask for catalog XP-1



Also for tracer-guided
ENGRAVING
PROFILING
GRADUATING

new hermes ENGRAVING MACHINE CORP
13-19 University Place New York 3, N.Y.



this is a record of leadership

This Visicorder Oscillograph record* is a symbol of the leadership that is typical of Honeywell engineering. In laboratories all over the world the Visicorder's instantly-readable direct records are showing the way to new advances in rocketry, control, computing, product design and component test, and in nuclear research.

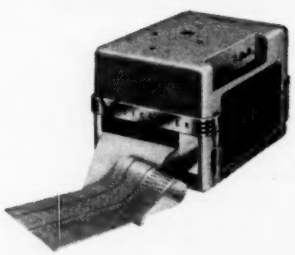
The Model 906 Visicorder is years ahead of the trend. It is the first recording oscillograph that combines the convenience of direct recording with the high frequencies and sensitivities of photographic-type instruments. The Visicorder alone among oscillographs makes it possible for you to monitor high-speed variables as they go on the record.

To record directly the high frequency variables you need to study, use the Visicorder Oscillograph. Call your nearest Minneapolis-Honeywell Industrial Sales Office for demonstation.

*reproduced half size

Minneapolis-Honeywell Regulator Co., Heiland Division, 5200 East Evans Avenue, Denver 22, Colorado.

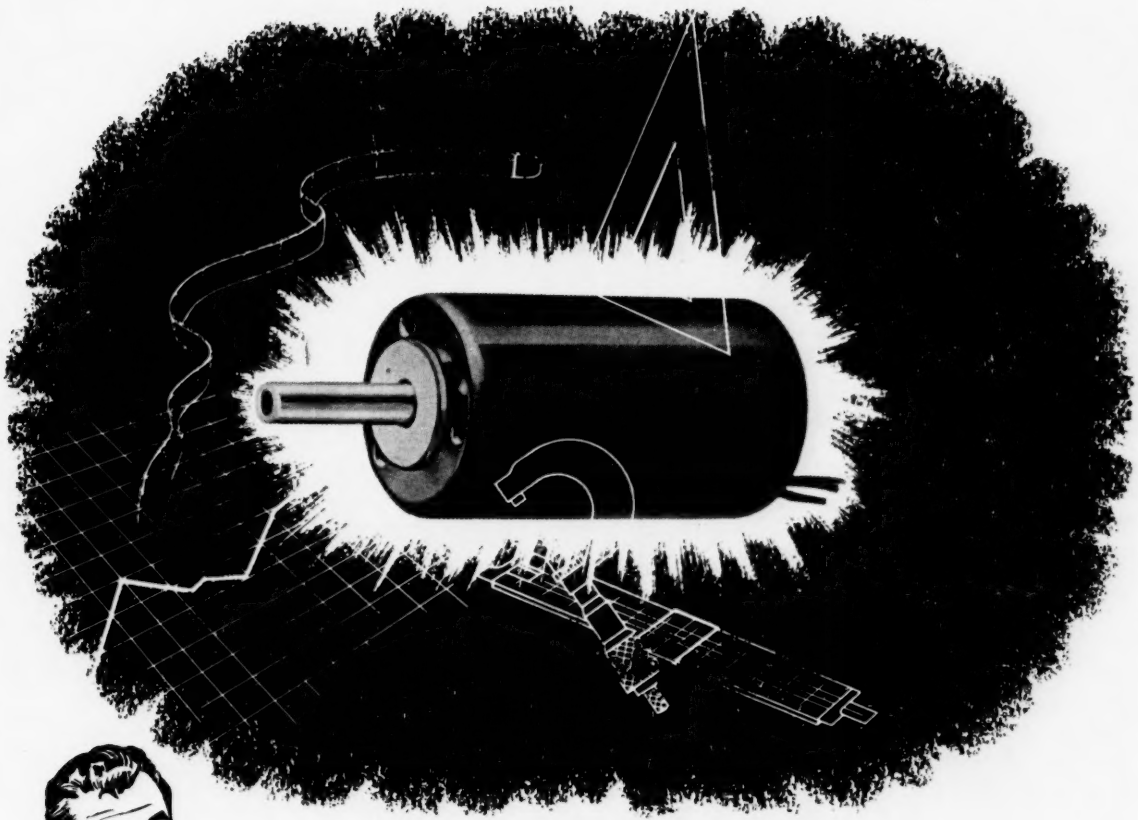
Reference Data: Write for Visicorder Bulletin



MINNEAPOLIS **Honeywell**

Heiland Division

For more information circle **28** on inquiry card.



HOW DO YOU MEASURE A MOTOR?

EAD'S 1" Diameter Motor Exceeds 3500 Hours at 20,000 RPM

An EAD customer required a small, 1" diameter motor with a minimum life of 1000 hours, running at 20,000 rpm at a temperature of 85° C. The result was peak performance at specified temperature and speed for more than 3500 hours operation with no signs of deterioration!

This is a typical example of EAD's high-output, long-life, power-packed miniature components doing a big job!

by PRECISION

Consider first the excellence of the electro-mechanical design and the "built-in" precision. What quality are the bearings and lubrication? Can you hold air gap clearances of less than .002" required for high efficiency? How does the motor measure up under extreme environmental conditions?

EAD pioneered precision in small motors . . . specialized in small precision motors for more than 15 years!

by PERFORMANCE

Can you obtain a 1-inch diameter motor with high-power output and efficiencies exceeding 60%? Is it capable of extremely high speeds for fan or blower applications requiring maximum air deliveries? How does it measure up in reliability, long life in control equipment, actuators, pumps, generator drives, gear motors, antenna drives, or automatic devices.

EAD motors are performance-proven for more than 15 years in vital, stringent military and industrial uses!

by PRICE

Can you get premium performance, high-accuracy, specialized design at production prices not much greater than you now pay for standard motors?

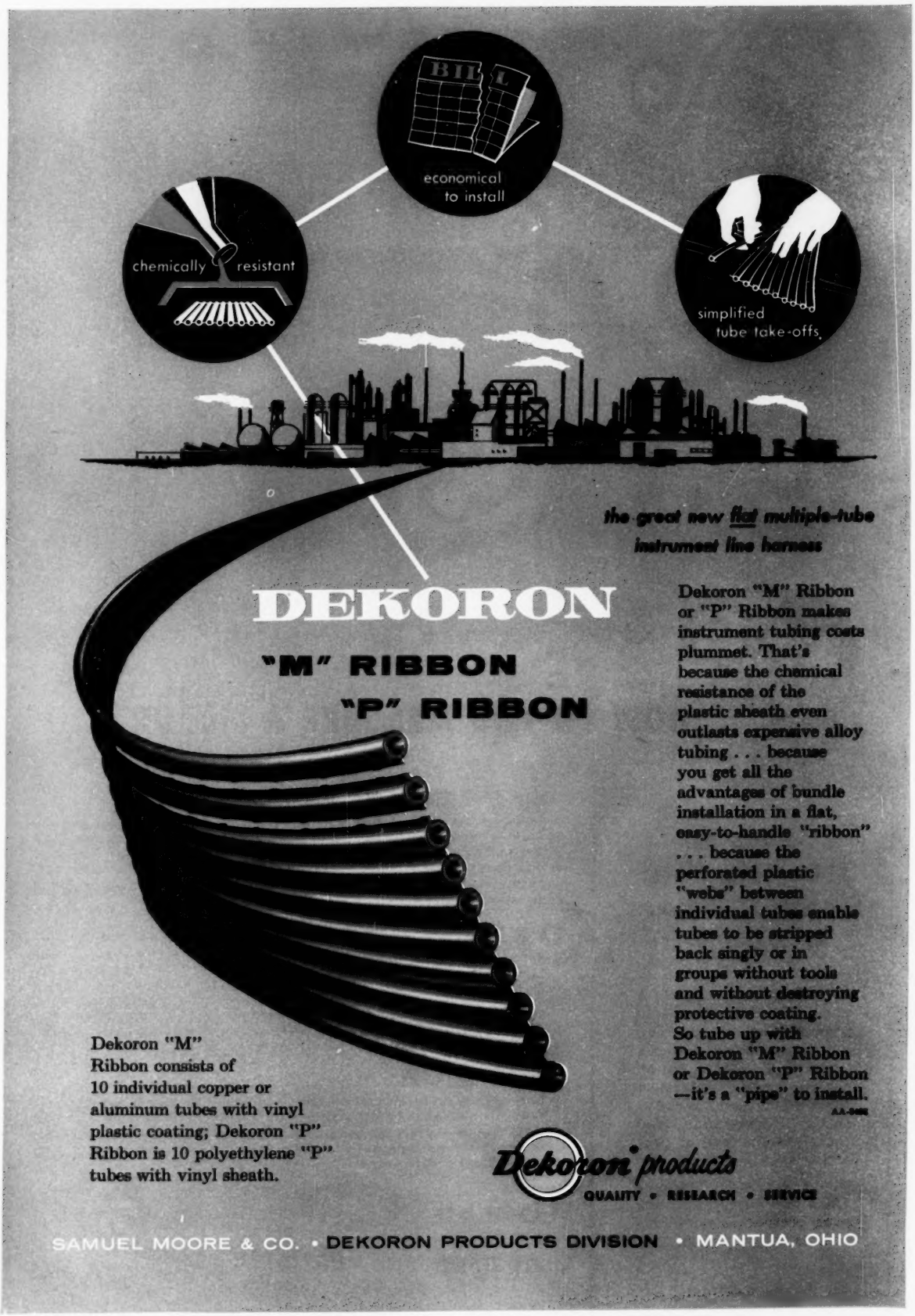
EAD has the years of experience to convert complex engineering designs into mass-producible items. You get highly specialized units at standard motor prices!

Get all 3 at EAD

EAD *Eastern Air Devices, inc.*

347 CENTRAL AVENUE, DOVER, NEW HAMPSHIRE

For more information circle **29** on inquiry card.



the great new flat multiple-tube instrument line harness

DEKORON

"M" RIBBON
"P" RIBBON

Dekoron "M" Ribbon or "P" Ribbon makes instrument tubing costs plummet. That's because the chemical resistance of the plastic sheath even outlasts expensive alloy tubing . . . because you get all the advantages of bundle installation in a flat, easy-to-handle "ribbon" . . . because the perforated plastic "webs" between individual tubes enable tubes to be stripped back singly or in groups without tools and without destroying protective coating. So tube up with Dekoron "M" Ribbon or Dekoron "P" Ribbon —it's a "pipe" to install.

Dekoron "M" Ribbon consists of 10 individual copper or aluminum tubes with vinyl plastic coating; Dekoron "P" Ribbon is 10 polyethylene "P" tubes with vinyl sheath.

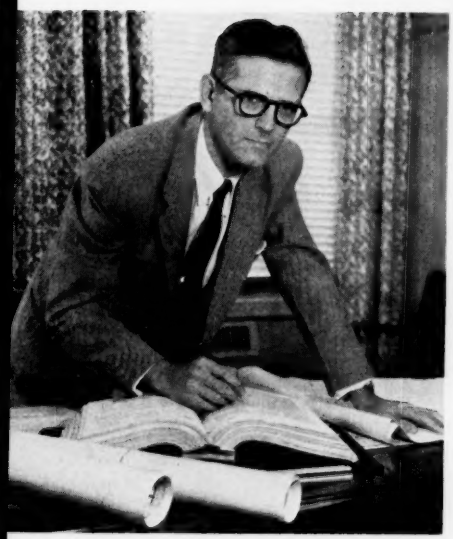
Dekoron® products
QUALITY • RESEARCH • SERVICE

SAMUEL MOORE & CO. • DEKORON PRODUCTS DIVISION • MANTUA, OHIO

For more information circle **30** on inquiry card.

SIGNIFICANCE

Biographies of significance



BLAW-KNOX Company's Chemical Plants Division has engineered and built many plants of the country's leading manufacturers. A pioneer in automatic reactor and processing plants, Blaw-Knox has constructed the major part of such AEC installations as the Savannah River Project. Other types of plants offered by the Chemical Plants Division include wood utilization, fats and oils, resins and plastics, low temperature, petroleum and petrochemicals, synthetic fuels, chlor-alkali, etc. The Principal Instrument Engineer of such a company is obviously a key position in our industry. This month we acknowledge the important position and status of Leslie Driskell, Principal Instrument Engineer of Blaw-Knox Chemical Plants Division.

LESLIE R. DRISKELL

LES DRISKELL is the Principal Instrument Engineer at the Chemical Plants Division of Blaw Knox Company in Pittsburgh. Back in 1934, when he was seventeen years old, he graduated with top honors from du Pont High School in Louisville, Kentucky.

Les entered the University of Louisville on a scholarship, majoring in mathematics. However, before graduation came along the great depression forced him out of school. He held quite an array of jobs over the next few years: bookkeeper, secretary, technical librarian, cost accountant, personnel director, etc.

He was secretary to the Plant Manager of Joseph E. Seagram & Sons when that company decided to modernize its plant at Louisville and install a completely instrumented distillery. As the company did not have an instrument department, Les was offered the opportunity to set one up. He attended instrument schools and read up about instrumentation in other plants, particularly from issues of *Instruments* magazine. He took several engineering courses by mail order. He went to Speed Engineering School at nights, and became the first Instrument Superintendent of Seagram's Louisville plants.

During World War II he acted as instructor for Purdue University, Lafayette, Indiana, and taught extension classes in industrial instruments and pyrometry under the Engineering Science Defense Training Program.

For two years he supervised instrument construction and testing with Riggs-Distler Co. of Baltimore and for three years he was with E. I. du Pont de Nemours & Co. as foreman of the instrument department at the Louisville Neoprene Works.

In 1947 Les went to Pittsburgh with Blaw Knox Company as instrument engineer. Here he has been responsible for the instrument design on many interesting projects, including synthetic fuels, coal gasification, high purity tonnage oxygen, fat splitting, jet engine testing facilities, plastics, petroleum processes, synthetic rubber, ammonia synthesis, high-energy fuels, etc. He engineered the instrumentation of the AEC's materials Testing Reactor and a large part of The Savannah River Project, a project called "the greatest construction project in world history" by *Time* magazine.

Les became Principal Instrument Engineer at Blaw Knox in 1956, and now directs the activity of an eighteen-man department. Each day this group tackles a galaxy of instrument engineering problems in the design of every conceivable kind of plant. A typical problem might require pumps, level controllers, temperature controllers, etc.—and "*Instruments & Automation* is used continuously in the never-ending search for proper hardware," says Les. "Not only I, but most of the instrument engineers here at Blaw-Knox read *I&A*."

Other of the company's 12,000 employees work in five plants in four states, grouped in (1) the Fabricated Products Operations, (2) the Foundry and Mill Machinery Division with eight works in Pennsylvania, West Virginia, and Indiana, and (3) the Power Piping and Sprinkler Division in Pittsburgh, Pa. The company was founded and reared on road machinery equipment, but is now a dominant factor in other markets which, beside chemical plants, include steel mill equipment, steel flooring, television towers, process equipment, dairy products, prefabricated piping, and fire protection systems. Thus Blaw-Knox is serving practically every large industry in the world.

For many years Les has been active in the Instrument Society of America. He has held many offices in the local sections, including the Presidency of the Pittsburgh Section in 1954-55.

Les is a member of the Committee on Electronics and Instrumentation of the Allegheny County school system, and a member of the Committee on Automation and Industrial Technology of the Pittsburgh Board of Education. The purpose of these groups is to assist in the establishment of technical curricula at the high-school level for students of exceptional ability.

Les was assisted throughout his career by his childhood sweetheart, Doris Bentel, from Kentucky, whom he married in 1937. They live in suburban Mt. Lebanon, Pennsylvania, with their seventeen year old daughter Sharon (rock-and-roll) and seven year old Danny (bang! bang!)

Emery NEWS

WEIGHING SYSTEM

BIN, TANK AND HOPPER EDITION No. 6

Covering design, development and application data on Emery Weighing Systems for industrial applications

HOOKER ELECTROCHEMICAL COMPANY USES EMERY LOAD CELLS TO GET ACCURATE MEASUREMENT AND INDICATION OF FLUID IN TANKS

EMERY CELLS WERE SELECTED BECAUSE THEY WERE CONSIDERED MORE ACCURATE THAN LEVEL INDICATORS OR PLATFORM SCALES

GEORGE C. DUCKWALL
Plant Engineer

The Montague, Michigan, plant of Hooker Electrochemical Company was designed to tap the inexhaustible supply of subterranean salt in the area, and using an electrolytic process, turn it into caustic soda, chlorine and hydrogen. Total construction costs of the Hooker plant in Montague have been estimated at approximately $18 million.

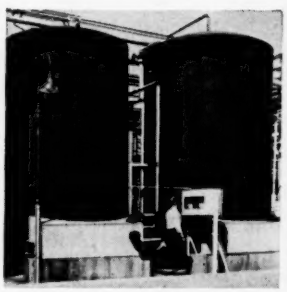
In equipping a modern plant such as this new Hooker installation, much care is given to the selection of every piece of industrial apparatus used.

Referring to the Emery Cells in use in tank weighing installations at the Montague plant, G. E. Duckwall, plant engineer, says, "Emery Cells were selected because they gave a more accurate measurement of the amount of fluid in the tanks than either level indicators or platform scales."

Five of the tanks in the Hooker installation stand on end and are supported at the tank bottom by Emery Cells. A sixth tank is mounted horizontally and is supported at both ends. To do this weighing job, Hooker is now using four Type EC-100 Cells and two Type EC-60 Cells. The only instrumentation involved are the dial indicators connected directly to each of the six cells.

Mr. Duckwall reports, "to date we have had good performance from the load cells and no malfunctions of the apparatus."

If you have a tank weighing problem, we will gladly recommend the type of Emery Load Cell and the instrumentation necessary to give you the best possible results.



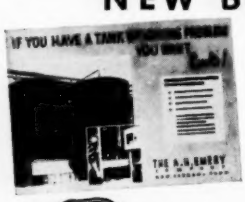
Worker reads on Emery Dial Indicators the weight of the contents of two vertical tanks. Each tank is supported by one Emery Load Cell.

Photo shows how Emery Load Cell supports frame which carries weight of tank. Indicator can be set to eliminate tare weight of tank and structure.

NOTICE

Our Engineering Department will gladly supervise a survey of your tank weighing needs. Just give us the opportunity of discussing your problem with you and you will find our representative at your service immediately.

NEW BULLETIN



Our new Bulletin 571 is just off the press! It discusses the results that you want from your tank weighing system and how to go about getting them. Be sure to send for your copy right away.

RESULTS, NOT MECHANICS, ARE IMPORTANT IN TANK WEIGHING

Engineers at The A. H. Emery Company have re-directed their thinking concerning problems in the tank weighing field to the point where the problem is approached in the light of *results wanted*.

Using this necessary result as the starting point, these engineers learn whether a simple dial-indicated result is wanted . . . whether a printed tape or special printed ticket will serve the purpose better . . . whether some other type of recording would be preferable . . . or whether a control function is needed.

The weighing equipment is then designed to produce the required result. May we talk about the *results* you want from your weighing system?

THE A. H. EMERY CO. PRECISION SINCE 1872 FORCE MEASUREMENT

THE A. H. EMERY COMPANY

Pine Street • New Canaan, Conn.

For more information circle **31** on inquiry card.

* P.C. IN INSTRUMENTATION

* P.C.?—that's easy. It stands for PRECISION CONTROL—which is exactly what you get when you specify capillary tubing manufactured by Wolverine Tube. For the close ones—such as metering gases or liquids—you can specify plug-drawn, individually flow-tested Wolverine Capilator®—the finest capillary tube available.

For general control installations you can specify Wolverine small diameter capillary tubing which is held to commercial I.D. tolerances of plus or minus .002". This rigidly quality controlled tubing is available in random length coils of 200 feet or more—reflects through every foot the Tubemanship for which Wolverine is famous.

Next time you order capillary tube specify Wolverine. Write, too, for your free copy of Wolverine Tube's Capilator Book.

BUY AMERICAN

CALUMET & HECLA, INC.
CALUMET DIVISION
WOLVERINE TUBE DIVISION
FOREST INDUSTRIES DIVISION
CALUMET & HECLA OF CANADA LIMITED
CANADA VULCANIZER AND EQUIPMENT COMPANY LIMITED

WOLVERINE TUBE

Division of Calumet & Hecla, Inc.
1467 CENTRAL AVE., DETROIT 9, MICH.
Manufacturers of Quality-Controlled Tubing and Extruded Aluminum Shapes

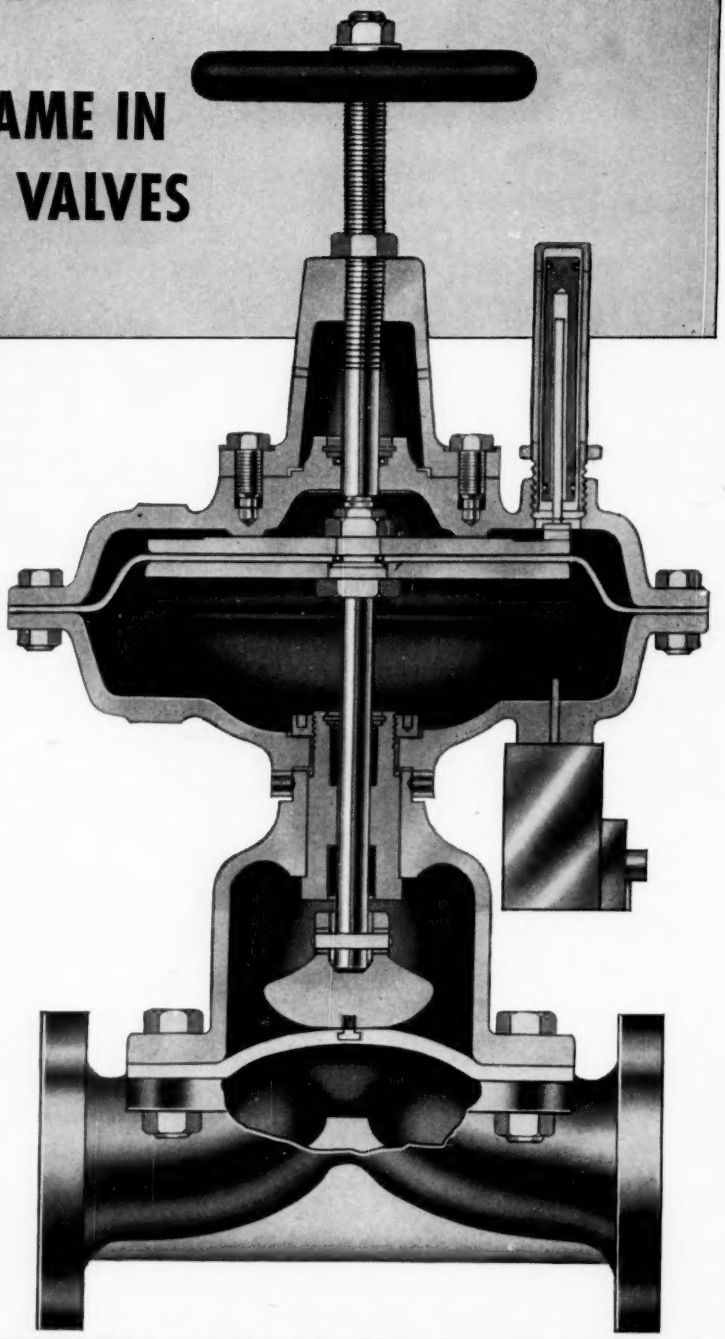
PLANTS IN DETROIT, MICHIGAN, AND DECATUR, ALABAMA. SALES OFFICES IN PRINCIPAL CITIES
EXPORT DEPARTMENT, 13 EAST 40TH STREET, NEW YORK 16, NEW YORK
6248

For more information circle **32** on inquiry card.

CONOFLOW...

THE FIRST NAME IN AIR OPERATED SAUNDERS VALVES

THOUSANDS IN USE IN LEADING COMPANIES



When you specify Conoflow Air Operated Saunders Valves your confidence is affirmed by thousands of successful installations. Many Conoflow Saunders Valves have been in constant, 24-hour-a-day service, year in, year out, requiring little or no maintenance.

When you specify Conoflow Close-Coupled Saunders Valves you know that you are getting the benefit of more years of experience in this line than any other valve manufacturer can offer. This *extra* engineering "know-how" enables Conoflow to provide:

- Valves in *all sizes* for both *on-off* and *throttling* control—with many original and time-proved optional features.
- Wholly integrated design—*complete valve assembly* made at the Conoflow factory by experienced men.
- Highest quality construction materials —the *right* material for the *right* job.
- Positive performance—every unit *completely tested* for dripless shut-off and peak operating efficiency before shipment.

When you specify Conoflow Saunders Valves you are certain that you are getting the *best* Saunders valve available . . . and at a *competitive price*.

WRITE FOR NEW BULLETIN HB-6 DESCRIBING THE COMPLETE LINE OF CONOFLOW SAUNDERS VALVES. IT WILL BE MAILED PROMPTLY.

Cono Controls®

CONOFLOW CORPORATION
2100 ARCH STREET, PHILADELPHIA 3, PA.

SUBSIDIARY OF WALWORTH

FOREMOST IN FINAL CONTROL ELEMENTS

CC706

For more information circle **33** on inquiry card.

NOW... *Ruggedized*

PANEL METERS *with* LONG 250° SCALES

First with a comprehensive line of ruggedized d-c and a-c panel meters, Weston now provides these instruments in the popular 3½" size with *long readable scales, higher accuracy, improved sensitivities* and *superior ballistic characteristics.* Designed to meet, *and surpass in scale length and accuracy,* all requirements of MIL-M-10304A. They incorporate all Weston ruggedized design features including integrally molded and bonded shock mounting plates; shock-absorbing spring-backed jewels; screw driver type zero correctors, front sealed; anti-static treated plastic sealed windows; self shielding etc. For all the facts, consult your nearest Weston representative, or write—Weston Electrical Instrument Corporation, Newark 12, New Jersey.

WESTON *Instruments*

A DAYSTROM UNIT

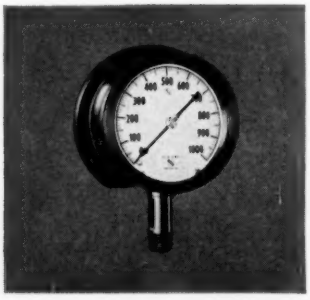
For more information circle **34** on inquiry card.

Why does the BOURDON TUBE in the ASHCROFT DURAGAUGE insure sustained accuracy?

FOR FAST SERVICE, get in touch with your Industrial Supply Distributor. He is fully acquainted with Ashcroft Duragauges and their proper selection for all kinds of applications.

8 TUBE MATERIALS permit selection of the *best metal* for particular service conditions. These materials include phosphor bronze, alloy steels, "K" Monel, stainless steels, and beryllium copper.

Every Bourdon tube used in the Ashcroft Duragauge is extra-wide – highly sensitive to slight pressure changes. Socket and tip joints are welded or brazed, then stress relieved after assembly, to assure maximum safety and uniform structure for highest corrosion resistance and strength. Each tube assembly is "whip tested" at pulsating pressures approximately 50% higher than its pressure rating to insure calibration stability.



The Ashcroft Duragauge is available with all-stainless-steel movement or stainless steel with nylon bearings and pinion gear. A choice of case designs and materials, dial sizes and pressure ranges readily satisfy the most exacting requirements. Whatever the working pressures or corrosive conditions of your operations, specify Ashcroft Duragauges and be sure of highest sustained accuracy and long service life.

In Canada: *Manning, Maxwell & Moore of Canada, Ltd., Galt, Ontario*

ASHCROFT GAUGES

A product of **MANNING, MAXWELL & MOORE, INC.** STRATFORD, CONNECTICUT

MAKERS OF 'AMERICAN' INDUSTRIAL INSTRUMENTS, 'CONSOLIDATED' SAFETY AND RELIEF VALVES, 'AMERICAN-MICROSEN' INDUSTRIAL ELECTRONIC INSTRUMENTS, *Stratford, Conn.* 'HANCOCK' VALVES, *Watertown, Mass.* 'CONSOLIDATED' SAFETY RELIEF VALVES, *Tulsa, Oklahoma.* AIRCRAFT CONTROL PRODUCTS, *Danbury & Stratford, Conn. and Inglewood, Calif.* "SHAW-BOX" AND 'LOAD LIFTER' CRANES, 'BUDGIT' AND 'LOAD LIFTER' HOISTS AND OTHER LIFTING SPECIALTIES *Muskegon, Mich.*

For more information circle **35** on inquiry card.

MULTIFLEX® BELLOWS and bellows assemblies

Multiflex Bellows are a quality product and incorporate our improved method of producing thin wall tubing from which Multiflex Bellows are made. Hydraulically formed or roll formed bellows are produced as requirements may demand.

***typical bellows assembly**

New Catalog is now available!

CONTENTS: Bulletin No. 121 contains information about thin wall tubing, bellows characteristics, life of bellows, various types of bellows ends, bellows tables, standard sizes seamed bellows, measures of volume, measures of pressure and weight, vapor pressure temperature curves.

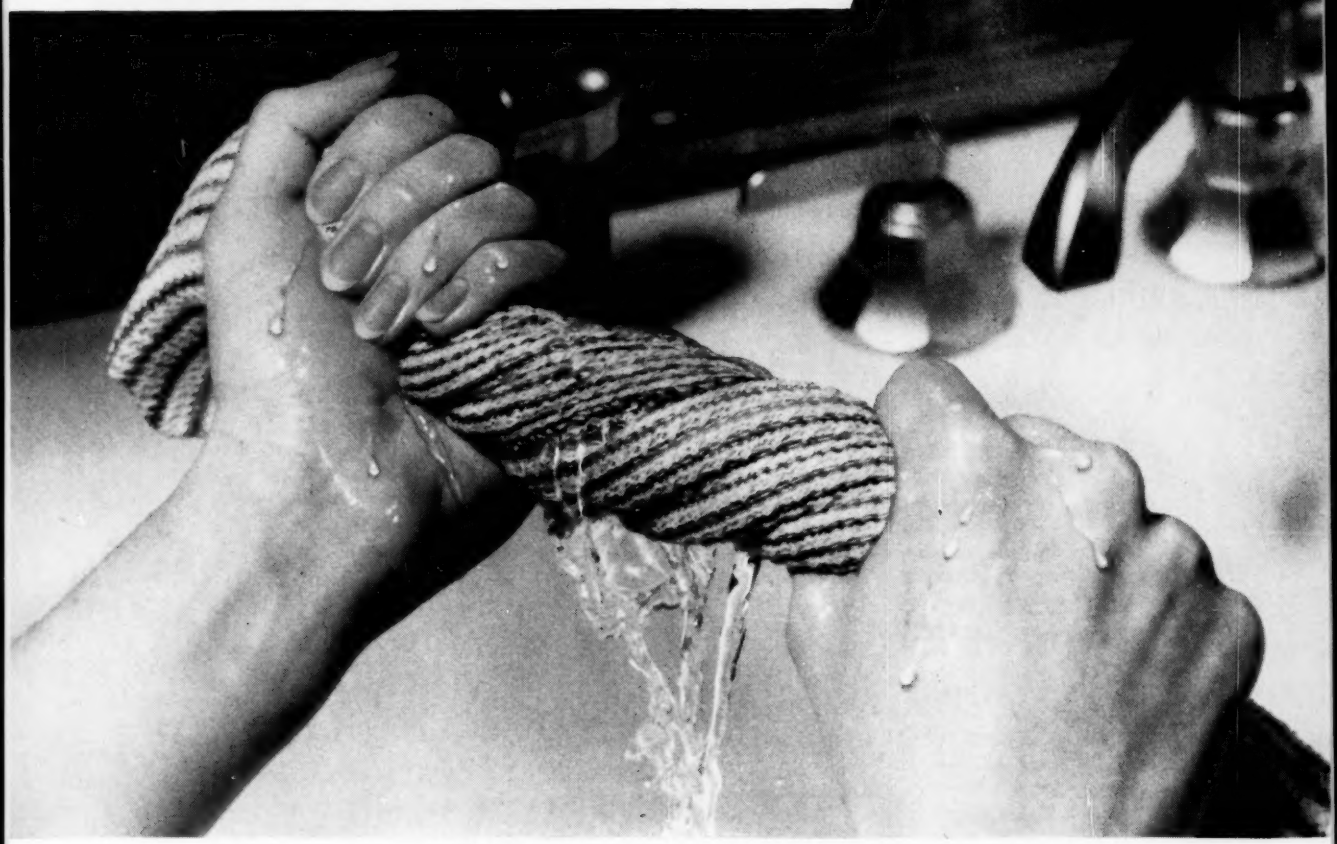
Some territories available to qualified manufacturers representatives

The **BISHOP & BABCOCK** *Mfg. Co.*
4901 HAMILTON AVENUE CLEVELAND 14, OHIO

makers of thin wall metallic bellows for over fifty years.

For more information circle **36** on inquiry card.

Sometimes you can guess at torque . . . BUT



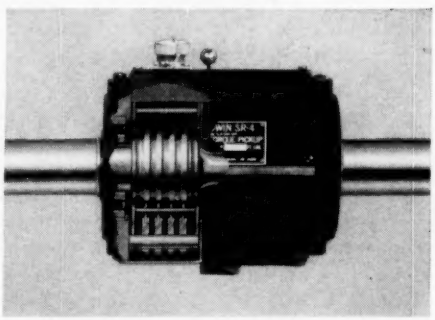
With SR-4® Torquemeters, you can measure and control all industrial torques to ±¼% accuracy

It isn't necessary to measure the exact amount of torque in order to wring out a dishcloth. But in industry, it's often vital that the exact amount of torque on a shaft be known.

You can use Baldwin SR-4 Torquemeters to measure a few inch-ounces or thousands of foot-pounds, and with consistent accuracy to within ±¼%. They convert torsion changes directly into changes in electrical energy, measure torque independently of speed, and take no power from the drive shaft. A wide variety of instruments can be used with SR-4 Torquemeters, ranging from millivoltmeter and battery to a computing instrument reading horsepower directly.

Baldwin SR-4 Torquemeters offer unlimited application opportunities. Present uses include torque measurement of viscosity, in engine dynamometers, for pump testing, in propeller drive shafts and helicopter rotor assemblies, and hundreds of other applications in design and production testing.

Whatever *your* torque measurement problem, a B-L-H representative is ready to serve you. For more complete information on SR-4 Torquemeters, write today for your free copy of Bulletin 4308.



The Type A SR-4 Torquemeter is a self-contained unit with housing and brush assembly suspended on a shaft by ball bearings. It employs SR-4 Bonded Wire Strain Gages in a Wheatstone bridge circuit. Baldwin torquemeters have been built for shafts from ¼ in. diameter to 18 in.; for zero rpm to 35,000 rpm; and from 10 in.-oz. capacity to 4,200,000 in.-lb.

BALDWIN · LIMA · HAMILTON

Electronics & Instrumentation Division

Waltham, Mass.

SR-4® strain gages • Transducers • Testing machines

For more information circle **37** on inquiry card.

EVENTS —CONTINUED

December 1-6

Annual Meeting of American Society of Mechanical Engineers, Hotels Statler, Sheraton McAlpin, New York, N. Y. For information write L. S. Dennegar, 29 West 39 St., New York, N. Y.

December 2-6

26th Exposition of Chemical Industries, New York Coliseum, New York. For information write E. K. Stevens, 480 Lexington Ave., New York 17, N. Y.

December 8-11

Eastern Joint Computer Conference, sponsored by IRE, AIEE and Assn. for Computing Machinery, Shoreham Hotel, Washington, D. C. For information write Morton M. Astrahan, IBM Corp., San Jose, Calif.

December 9-13

1957 (Seventh) Eastern Joint Computer Conference of the Institute of Radio Engineers, Association for Computing Machinery, American Institute of Electrical Engineers, Sheraton Park Hotel, Washington, D. C. For information write to Mr. Richard T. Burroughs, I.B.M. Corp., 1220 Nineteenth St., N.W., Washington, D. C.

January 30, 31, 1958

Seventh Annual Instrument Short Course co-sponsored by Southern California Meter Association and Los Angeles Harbor Junior College, at Los Angeles Harbor Junior College, Wilmington, Calif. For information write Thomas H. Ponton, 640 Fillmore St., Fillmore, Calif.

February 18

14th Annual Quality Control Clinic of Rochester Society for Quality Control, War Memorial, Rochester, N. Y.

March 17-21

1958 Trade show, atomic industry, International Amphitheatre in Chicago, Ill.

April 22-24

Electronic Components Conference, Ambassador Hotel—Los Angeles, Calif. For information write David M. Knox, Packard-Bell Electronics Corp., 12333 West Olympic Blvd., Los Angeles 64, Calif.

May 31-June 8, 1958

European Congress of Chemical Engineering and ACHEMA Congress, Frankfurt a.M., Germany. For information write DECHEMA, Dechema-Haus, Rheingau-Allee 25, Frankfurt a.m., West Germany.

June 9-13, 1958

Fourth International Automation Exposition, Congress, Conferences, and Clinics, New York Coliseum. For information write Richard Rimbach Associates, 845 Ridge Ave., Pittsburgh 12, Pa.

FIRST AND ONLY...

MINIATURE TWO PEN 5" RECORDING POTENTIOMETER

Transistor Amplifiers

exclusive from...

westronics® INCORPORATED

$1195.00*

THE ULTIMATE IN AN ACCURATE, READABLE, MINIATURE RECORDING POTENTIOMETER, WITH THESE ADVANCED FEATURES

- 5-inch strip chart record.
- Two pens, each traveling the full 5 inches.
- 1-second maximum balancing time.
- Table top or panel mounting.
- Panel space 9⅝" W x 8½" H
- Margin marker pens.
- Paper supply indicator front of recorder.
- Ball bearings in pen drive system.
- New concept in front set limit switches.
- 0.5% accuracy on both pens.
- Completely transistorized amplifiers, no vacuum tubes.
- MV or TC Calibration
- Minimum Span: 1 MV
- Standardization: Mercury cell.
- Simple sub-assembly type construction for easy maintenance. (Entire recorder rolls forward out of case.)

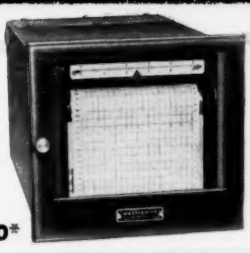
PLUS THESE OPTIONAL FEATURES:

- One front set SPDT switch and 3 SPDT back set switches each independently adjustable over the entire range on each pen.
- Transmitting slidewires.
- Selsyn motor chart drive.
- 3 speed quick change chart drive.
- Left and/or right margin marking pens.

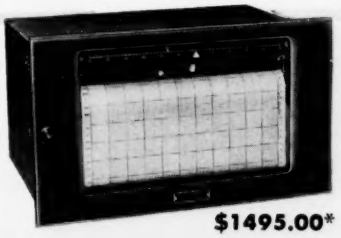
WESTRONICS RECORDING POTENTIOMETERS FOR EVERY NEED

One Pen Miniature 5" Recording Potentiometer

- 5" strip chart record.
- Continuous Automatic Standardization with electron tube amplifiers.
- Requires only 9⅝" by 8½" panel space.
- Accuracy better than 0.5%.
- One second full scale pen travel.
- Weighs less than 25 pounds.



$490.00*



Two Pen 11" Recording Potentiometer

- 11" strip chart recorder (12" overall width).
- Completely transistorized amplifiers.
- Reduced maintenance.
- Small size.
- Immediate recording . . . no warm-up time.
- Optional synchronous motor or Selsyn motor chart drive.

$1495.00*

*BASE PRICE

For more information circle 38 on inquiry card.

Instrumentation News

• *News of instrumentation and automatic control in modern industry* •

BRISTOL EXPANDS

Steps Up Instrument Service With New Branch Factories in Los Angeles and Houston

5 Branch Factories Plus 44 Service Centers Now Speed Instrument Service Throughout U. S. and Canada.

The new branch factories represent a major expansion of existing instrument repair and service facilities in these cities, and surrounding areas. The new branch factories are staffed with thoroughly trained Bristol field engineers and technicians and have all the equipment necessary for manufacturing standard instruments and for completely rebuilding and calibrating any Bristol instrument. (Every such factory-reconditioned instrument carries a "new" guarantee.)

The Los Angeles and Houston branch factories bring the total number of branches to five—others being located at San Francisco, Chicago and Toronto (Bristol Company of Canada, Ltd.).

The new Los Angeles branch factory, located at 6800 East Acco Street, will bring top notch instrument service to the rapidly growing West Coast electronics and aircraft industries. The Houston branch will be of particular interest to instrument users in this Southwestern center of the petroleum and petrochemical industries.

NEW PITTSBURGH HEADQUARTERS

PITTSBURGH, PA.—As part of its overall expansion, The Bristol Company announced a new and enlarged branch office headquarters at 2250 Noblestown Road, this city.

The new office will augment the already outstanding instrument service Bristol has given customers in this area since establishment of the first Bristol branch office here in 1906.

New Los Angeles Bristol Branch Factory

New Pittsburgh Headquarters

New Houston Branch Factory

"ON-THE-SPOT SERVICE" for users everywhere

WATERBURY, CONN.—The recent opening of new branch factories and offices will step up on-the-spot services for Bristol instrument users, wherever located.

Bristol customers services begin long before an instrument is purchased and continue long afterward. Bristol field and application engineers, throughout the U. S. and Canada, are available to recommend equipment best suited to your job.

NO AXES TO GRIND

You are assured of an unbiased recommendation because Bristol makes almost every kind of instrument – full size, miniature, electronic, pneumatic, electric, mechanical. Bristol process instrument specialists are ready to advise you on up-to-the-minute control systems for new tough or unusual processes.

After purchase, you have available on short notice—often within a few hours—a nationwide staff of factory-trained, widely experienced Bristol service engineers. For a reasonable rate, they install, check, adjust and inspect Bristol instruments in your plant. You can arrange to have a Bristol service engineer call at regular intervals to keep equipment in top operating condition.

Complete factory reconditioning is now available at 5 factories: San Francisco, Los Angeles, Chicago, Houston, the main factory at Waterbury, and the Bristol Company of Canada, Ltd., Toronto. Write for full particulars on Bristol instruments or service. The Bristol Company, 113 Bristol Road, Waterbury 20, Conn. 7.25

BRISTOL *TRAIL-BLAZERS IN PROCESS AUTOMATION*

AUTOMATIC CONTROLLING, RECORDING AND TELEMETERING INSTRUMENTS

For more information circle **39** on inquiry card.

EVENTS —CONTINUED

November 13-15

Eighth National Conference on Standards of American Standards Association, St. Francis Hotel, San Francisco, Calif. For information write D. E. Denton, American Standards Association, 70 East 45 St., New York 17, N. Y.

November 15-16

NEREM, 1957 (New England Radio-Electronics Meeting) sponsored by Boston and Connecticut Valley Sections of the I.R.E., Mechanics Hall, Boston, Mass. For information write Donn S. Randal, Larcom Randall Advertising, Inc., 51 Melcher St., Boston 10, Mass.

November 18-21

Conference on Magnetism and Magnetic Materials, Sheraton-Park Hotel, Washington, D. C. For information write John J. May, 552 Washington Bldg., Washington 5, D. C.

November 18-22

Seminar on Industrial Standardization, St. Francis Hotel, San Francisco, Calif. For information write Dr. John Gaillard, Box 273, Route 1, Briarcliff Manor, N. Y.

November 19-21

Airlines Electronic Engineering Committee of Aeronautical Radio, Inc., Fall Meeting, San Francisco, Calif.

if You

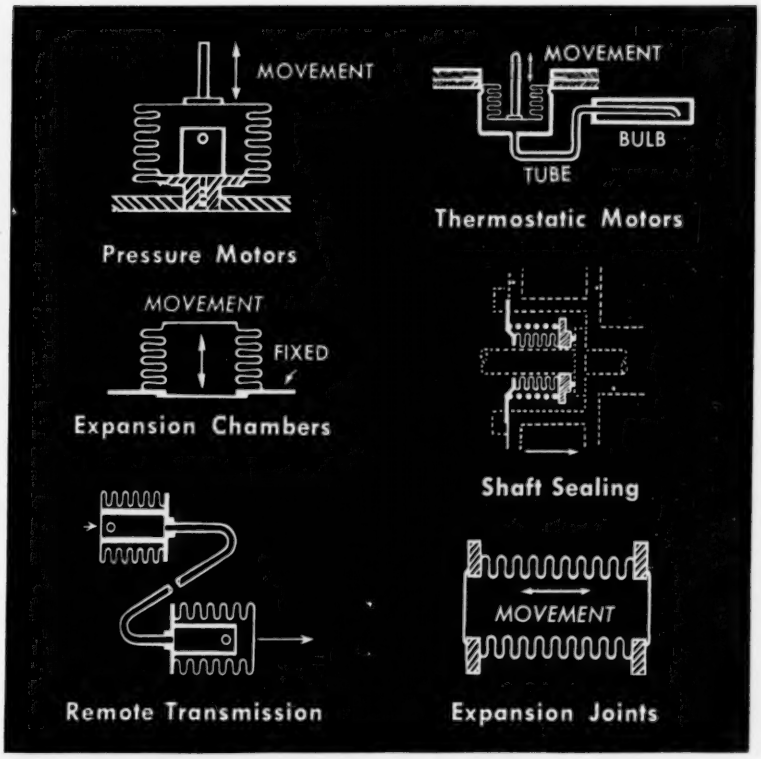
manufacture automation, instrumentation or automatic control components, devices or systems . . . exhibit at the

FOURTH INTERNATIONAL
AUTOMATION
EXPOSITION and CONGRESS

NEW YORK COLISEUM
JUNE 9 to 13, 1958

For descriptive brochure and list of products successfully exhibited at previous Automation Shows, contact

RICHARD RIMBACH ASSOCIATES, Mgmt.
845 Ridge Ave., Pittsburgh 12, Pa.



ELIMINATE DESIGN "WEAK SPOTS" WITH Bridgeport SEAMLESS BELLOWS

The simple construction, straightforward operation, and light weight of Bridgeport seamless metal bellows make them the best answer for many temperature, pressure, and mechanical design problems. Hydraulically formed without soldered seams, they provide added strength and precision in shaft sealing, in obtaining controlled movement, in absorbing expansion or shock, in maintaining equal or differential pressures, and in transmitting motion remotely.

Bridgeport also offers two plus factors to make the most of any bellows application. Through integrated engineering of the bellows and all accessories, Bridgeport can supply complete bellows assemblies of many types, sizes, and metals. Ultra-modern production and quality control facilities assure increased uniformity and cost savings.

SEND FOR BELLOWS BULLETIN-TL

Mr. Controls®

Robertshaw-Fulton
CONTROLS COMPANY

BRIDGEPORT THERMOSTAT DIVISION
MILFORD • CONNECTICUT

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Here's why it pays to CALL FOR HELP

...*first thing instead of last*

If you want to do anything "by the numbers," first thing to do is call the No. 1 man . . . your Veeder-Root District Engineer. Because he's an *original thinker* like yourself when it comes to designing or building *Count*rol into any type of product or process.

He knows his book on the most complete line of standard electrical, mechanical and manual counters made anywhere in the world. And from this line he can very likely adapt or modify a standard counter to your special needs. This saves cost and time in engineering, purchasing, assembly.

And you get a lot of new user-benefits to merchandise . . . direct readings, rather than dials and scales . . . remote indication from plant to office if needed . . . production figures that serve as a fair base for wage and incentive payments, production and stock *Count*rol, tax computation . . . and as proof of your own performance guarantee. So call the V-R man in, *when you begin* . . . look him up in your local phone book, or write direct to:

VEEDER-ROOT INC., Hartford 2, Connecticut

Added Evidence that...

Everyone Can Count on VEEDER-ROOT

Hartford, Conn. • Greenville, S. C. • Chicago • New York • Los Angeles • San Francisco • Montreal • *Offices and Agents in Principal Cities*

For more information circle **42** on inquiry card.

Events

November 2-10

INTERKAMA (International Congress and Exhibition of Measuring Instrumentation and Automation), Dusseldorf, Germany. For information write Nordwestdeutsche Ausstellungs-Gesellschaft m. b. H., Ehrenhof 4, Dusseldorf, West Germany.

November 4-8

Fourth Institute on Electronics in Management, American University, Washington, D. C.; for information write Director, Fourth Institute on Electronics in Management, The American University, 1901 F Street, N.W., Washington 6, D. C.

November 6-8

10th Annual Conference on Electronic Techniques in Medicine and Biology, sponsored by ISA and AIEE, Boston, Mass. For information write H. S. Kindler, Instrument Society of America, 313 Sixth Avenue, Pittsburgh 22, Pa.

November 6-8

I.R.E. 1957 Aero-Com Symposium, Hotel Utica, Utica, N. Y. For information write R.A. Zachary, Vice Chairman for Technical Program, 11 Arbor Drive, New Hartford, N. Y.

November 7-8

Third Electronic Business Systems Conference, U.S. Grant Hotel—San Diego, Calif. For information write to Jac Wyman, P.O. Box 1448, San Diego 12, Calif.

November 7-8

7th Annual Symposium on New Ideas in Instrumentation Evolved from Nuclear Developments, Sheraton Hotel, Philadelphia, Pa. For information write Warren Brand, Conoflow Corp., 2100 Arch St., Philadelphia 3, Pa.

November 11-13

Radio-Electronics-Television Manufacturers Association Fall meeting, King Edward Hotel, Toronto, Canada. For information write J. A. Caffiaux, 650 Salmon Tower, 11 West Forty-Second St., New York 36, N. Y.

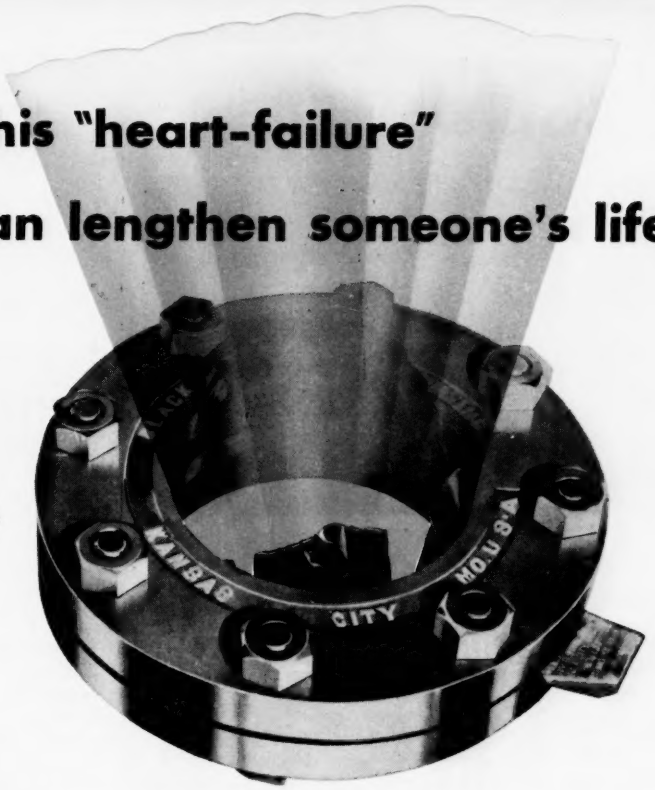
November 11-13

Instrumentation Conference and Exhibit, Institute of Radio Engineers, Biltmore Hotel, Atlanta, Ga. For information write B. J. Dacher, School of Electrical Engineering, Georgia Institute of Technology, Atlanta, Ga.

November 13-14

Mid-America Electronics Convention, Municipal Auditorium and Hotel Muehlebach, Kansas City, Missouri. For information write Richard L. Clarke, Midwest Research Institute, 425 Volker Blvd., Kansas City 10, Mo.

This "heart-failure" can lengthen someone's life!



Pictured above is what happens when a pressure vessel protected by a BS&B Safety Head develops pressures above safe limits. "Heart" of the Safety Head is the rupture disc, which bursts to relieve the overpressure instantly and completely—guarding against injuries to personnel and damage to plant equipment.

BS&B Safety Heads

protect pressure systems in every type industry

Thousands of BS&B Safety Heads are today protecting millions of dollars worth of property and equipment and countless human lives. There's a BS&B Safety Head suitable for many types of pressure systems containing air, gas, steam or liquid.

BS&B Rupture Disc—"Heart" of the Safety Head

BS&B rupture discs are designed to relieve pressures at any specified point from 3 to 100,000 pounds per square inch. They are available in standard sizes ranging from ¼ inch to 36 inches in diameter, and in special sizes and types for virtually any application.

If you use any type of pressured system, let us tell you more about BS&B Safety Heads and rupture discs. Call or write your nearest BS&B office or representative—or write to . . .

BLACK, SIVALLS & BRYSON, INC.

Safety Head Division, Dept. 2-V10
7500 East 12th St.
Kansas City 26, Mo.

HAGEN count switch

PAID FOR BY SAVINGS MADE ON JUST 1 TOOL

Simply set this Hagen Count Switch to the number of operations at which a tool should be changed. The count switch trips a switch after a preset number of electrical impulses . . . and thereby shuts down the machine automatically. Tool wear never reaches the point where tools must be ground down excessively to resharpen. That means increased tool life, reduced tooling costs and fewer rejects. Compare the savings on just *one* tool with the cost of this reasonably priced Hagen Count Switch. Chances are, the savings will be much greater.

This Hagen Model 70 Count Switch has 72 dial divisions . . . 72 possible settings. Dials are available with up to 54,000 counts. Accuracy: 1% of full scale range. Ideal for feed pumps and metering operations. Send coupon for Bulletin 780 — or data on the complete line of reset and repeating cycle timers and counters, interrupters and control assemblies.

HAGEN MANUFACTURING COMPANY, INC.
Moline, Illinois
Baraboo, Wisconsin
Subsidiary of Eagle Signal Corporation

HAGEN MANUFACTURING COMPANY, INC.
Dept. IA-1057, Moline, Illinois

☐ Please send free Bulletin 780 on Hagen Count Switch.

☐ Send free data on counters, timers, interrupters and control assemblies.

NAME AND TITLE

COMPANY

ADDRESS

CITY ZONE STATE

For more information circle **44** on inquiry card.

Book Reviews

Internal Pressure Gage for Instantaneous Static and Dynamic Pressure Measurements, by M. P. Peucker, PB 121171, 28 p, $.75, available from OTS, U. S. Department of Commerce, Washington, 25, D. C., describes a small precision electrical pressure gage which performs pressure measurements within models in supersonic wind tunnels and is capable of measuring absolute or differential pressures as low as 10mm of mercury full scale with an accuracy of 0.1% full scale. Small size permits its use internally for instantaneous measurements of static or pitot pressure.

Transistors, v. 1, 1956. RCA Laboratories, Princeton, N. J. 676 p. $4.50 (abroad, $4.70). 9¼ in. Papers concerned with research and development work of the Radio Corporation of America. Includes 31 papers not previously published, 10 reprinted from periodicals, and abstracts of 46 others. A few papers are of general scope; others deal with materials and techniques, devices, fluctuation noise, equipment for measurement and testing, and applications.

Radio Receiver Laboratory Manual, by Alex W. Levey. [C1956.] John F. Rider, New York 13, N. Y. 105 p., unbound. $2. 11 in. Elementary work, giving the student instruction in construction, analysis, testing and servicing radio receivers. The course includes construction of a six-tube, two-band heterodyne receiver.

Encyclopedia of Instrumentation for Industrial Hygiene, edited by Charles R. Yaffe, *and others.* 1956. Univ. of Michigan, Ann Arbor, Mich. 1243p. $22.50. 12½ in. With the realization that "the heart of modern industrial hygiene is measurement" the health agencies of the University of Michigan and the federal government have co-operatively issued this highly important volume. It is based on a symposium at the University of Michigan. Includes instruments for sampling and analyzing air; for evaluation of atmospheric pollution; for metering air and measuring its velocity; etc.

Servosystems Laboratory Manual, 1957, Educational Services Dept., Servo Corp. of America, 2020 Jerico Turnpike, New Hyde Park, N. Y. 32 p. Numerous photographs and diagrams. $2.00. Furnishes framework for an introductory laboratory course in servomechanisms, feedback controls systems, etc. Integrated class-tested experiments included.

Essential Tube Characteristics. [Ed. 7. 1957] General Electric Co., Schenectady, N. Y. 228 p., looseleaf binder. 75c. 8½ in. Contains information on 1593 types of tubes, and is intended to provide the service technician with reference material on every tube likely to be found in any home receiver—AM, FM, or television.

Automatic Coding. 1957 Franklin Institute, Philadelphia. 118 p., Unbound. $3. 9½ in. (Monograph 3.) Proceedings of a symposium held Jan. 24-25, 1957, at Franklin Institute. Includes eight papers, with discussion.

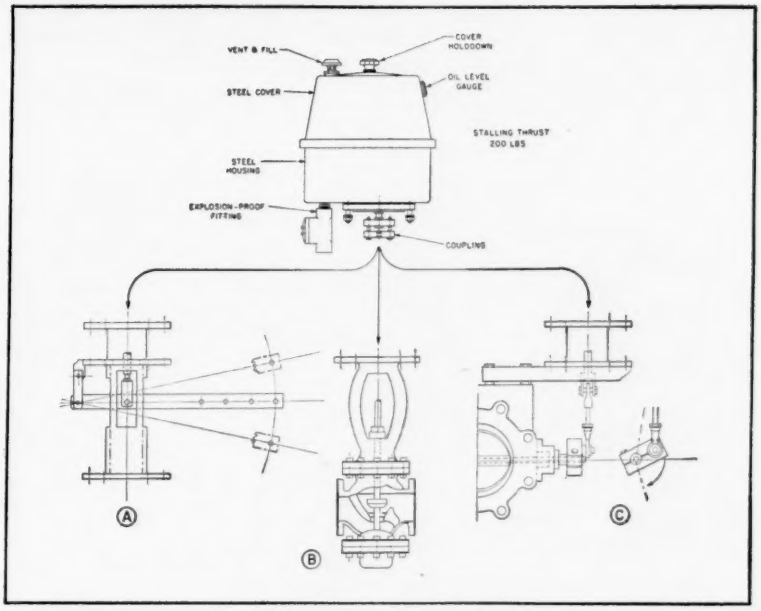
Askania Regulator Company NEWS

Automatic Controls for
PRESSURE, FLOW and COMBUSTION

As demonstrated at the ISA show

A NEW ASKANIA FINAL CONTROL ELEMENT

The Model RF-697 Electrohydraulic Valve Actuator



For Valves Requiring Less Than 200 lbs. Thrust

The Askania Model RF-697 Electrohydraulic Valve Actuator comprises a self-contained unit designed for proportional-position control, using signals from an electronic controller, manual station or directly from a measuring element.

Smaller, more compact and designed for operating valves with ½ to 1½ inch stroke requiring less than 200 lb. thrust, it operates from low level a-c or d-c signals. The d-c range is 1-5 or 4-8 milliamperes. For operation on a-c signals internal rectifiers are provided.

Design Provides Outstanding Operating Advantages

Exclusive design assures *stability*, *fast response*, and *dependable operation* marked by an ABSOLUTE MINIMUM OF MAINTENANCE. Note these important operating advantages:

1. Entirely self-contained
2. Operates directly from controller without relays or converters
3. Mechanically simple
4. Easy to mount on valve—simple to install
5. Competitively priced
6. Designed to meet Underwriters' Laboratories' explosion-proof requirements for Class I, Group D, Division 1 service.

Wide Valve Mounting Adaptability

The Model RF-697 Valve Actuator can be mounted on practically any valve. Typical valve mountings are shown at the right, above:

A. Mounted to provide a lever arm
B. Mounting for sliding-stem valve
C. Mounted on butterfly valve

Important Specifications

Valve Stem Speed...5 inches per minute at 150 lb. load
Valve Stem Stalling Thrust...200 lbs.
Valve Stem Stroke...½" to 1½"
Input Coil Resistance...Standard coil resistance approximately 12,000 ohms at operating temperature.

Send for Application Bulletin No. 38.3 for complete information on this new Electrohydraulic Valve Actuator. Write Askania Regulator Company, 268 E. Ontario Street, Chicago, Illinois.

ASKANIA REGULATOR COMPANY
"CONTROLS FOR INDUSTRY"
HYDRAULIC, ELECTRONIC CONTROLS & SERVOS, GENERAL SYSTEMS, ENGINEERING & COMPUTER SERVICE, VALVE ACTUATORS & CYLINDERS

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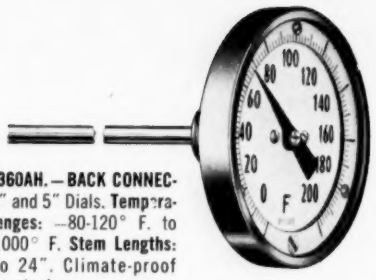
GPE

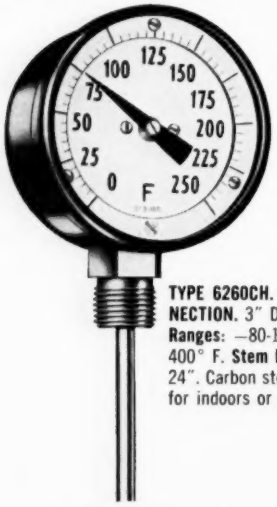
For more information circle **45** on inquiry card.



TYPE 6360AH. — BACK CONNECTION. 3" and 5" Dials. **Temperature Ranges:** —80-120° F. to +200-1000° F. **Stem Lengths:** 2½" to 24". Climate-proof stainless steel case.

GET ACCURATE "ON-THE-SPOT" TEMPERATURE READINGS . . .

INSTALL 'AMERICAN' BI-METAL DIAL THERMOMETERS



TYPE 6260CH. — BOTTOM CONNECTION. 3" Dial. **Temperature Ranges:** —80-120° F. to +50-400° F. **Stem Lengths:** 2½" to 24". Carbon steel case suitable for indoors or outdoors.

The Anti-Parallax MAXIVISION® Dial . . .
FOR SUREST, SHARPEST, EASIEST READABILITY
. . . Is Available Only In 'American' Thermometers

TYPE 6060AH. — "EVERY ANGLE" CONNECTION. 5" Dial. **Temperature Ranges:** —80-120° F. to +200-1000° F. **Stem Lengths:** 4" to 24". Climate-proof stainless steel case.

Nowadays fewer men are required in power and processing plants to inspect operations, so it is more important than ever to have observation points handy for them. 'American' Bi-Metal Dial Thermometers, installed at important check points, eliminate frequent trips to the control house. Inspectors can observe variations in process temperatures "on the spot" and take steps to effect corrections.

The economy of these thermometers goes far beyond the time-saving convenience of local indoor and outdoor readings. Their accuracy and utility contribute to lower costs. They provide the greatest sensitivity in bi-metal actuation. The low-mass single helix bi-metal coil is precisely centered in the stem to assure quick, accurate response to all temperature changes — to prevent the retard effect the coil can cause if rubbed against the stem wall.

The Maxivision dial is a split-level dial with pointer set on the same plane as the outside raised ring that carries the graduations. No perspective effect, no parallax! Readings are sure, sharp and accurate at a glance!

The availability of 'American' Bi-Metal Dial Thermometers in types with back, bottom or "Every Angle" connection permits selection to fit the conditions of each location. For example, the "Every Angle" type can be set at any point within 180° on two axes. Thus it is particularly recommended for installation above or below eye level or in close quarters where the types with fixed back or bottom connection would be impractical.

PHONE YOUR INDUSTRIAL SUPPLY DISTRIBUTOR for assistance in selecting the types of 'American Bi-Metal Dial Thermometer best suited to your needs. He can provide separable sockets in al materials and sizes normally required.

In Canada: *Manning, Maxwell & Moore of Canada, Ltd., Galt, Ontario*

AMERICAN INDUSTRIAL INSTRUMENTS

A product of **MANNING, MAXWELL & MOORE, INC.** STRATFORD, CONN.

MAKERS OF 'AMERICAN' INDUSTRIAL INSTRUMENTS, 'ASHCROFT' GAUGES, 'CONSOLIDATED' SAFETY VALVES, 'AMERICAN-MICROSEN' INDUSTRIAL ELECTRONIC INSTRUMENTS, *Stratford, Conn.* 'HANCOCK' VALVES, *Watertown, Mass.* 'CONSOLIDATED' SAFETY RELIEF VALVES, *Tulsa, Okla.* AIRCRAFT CONTROL PRODUCTS, *Danbury, Conn. and Inglewood, Calif.* "SHAW-BOX" AND 'LOAD LIFTER' CRANES, 'BUDGIT' AND 'LOAD LIFTER' HOISTS AND OTHER LIFTING SPECIALTIES, *Muskegon, Mich.*

For more information circle **46** on inquiry card.

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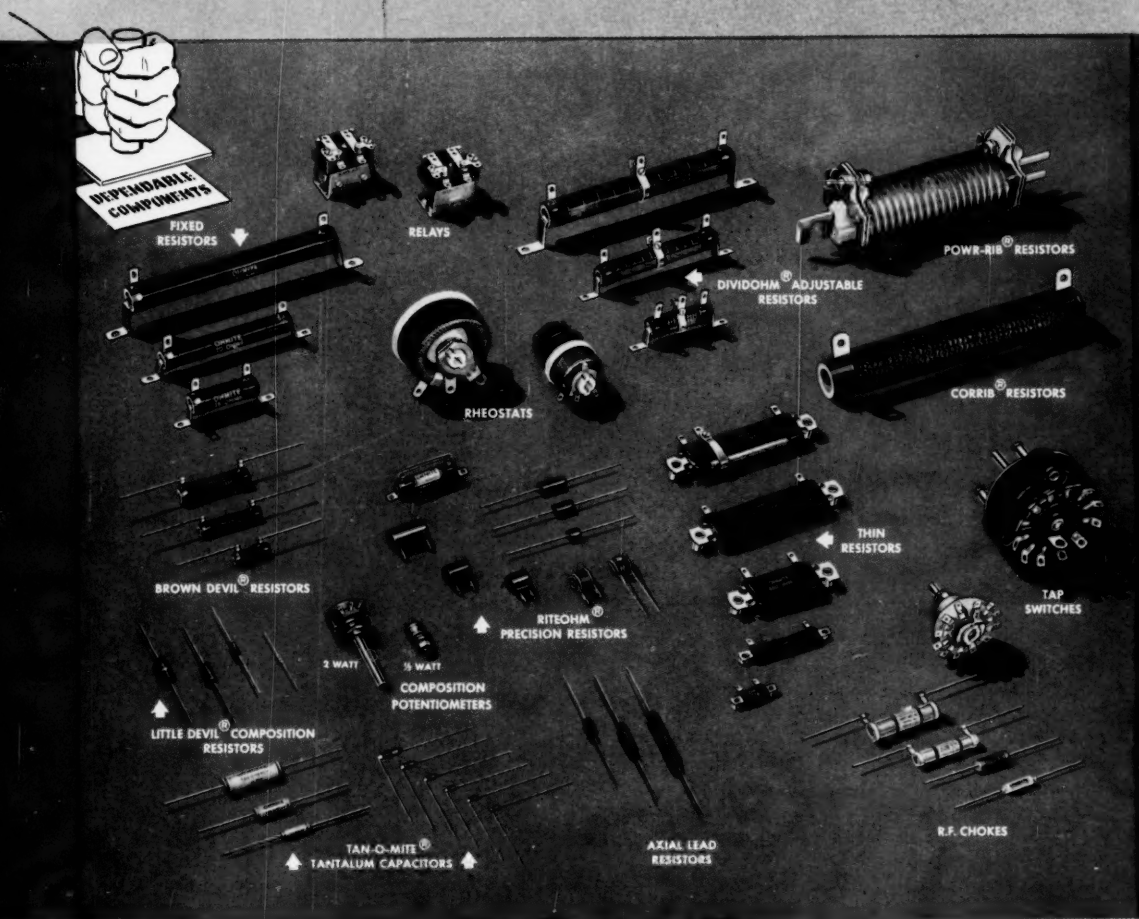
the complete line of industry-preferred COMPONENTS

Long life and dependability are synonymous with the name Ohmite. When you specify Ohmite components . . . you build reliability into your product. This reliability is backed by Ohmite's continuing research programs which explore new product ideas, improve present products, and develop more efficient manufacturing processes. All this plus the fact that Ohmite is the world's leading specialist in the manufacture of power-type resistance components —high quality rheostats and wire-wound resistors in the most complete range of sizes and types available to industry. Reliability is also characteristic of Ohmite tap switches, precision wire-wound resistors, molded composition resistors and potentiometers, general-purpose relays, subminiature tantalum capacitors, and R. F. chokes. Write on company letterhead for the complete Ohmite Catalog and Engineering Manual.



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RHEOSTATS • RESISTORS • RELAYS • TAP SWITCHES • TANTALUM CAPACITORS

OHMITE MANUFACTURING COMPANY • 3615 Howard Street, Skokie, Illinois

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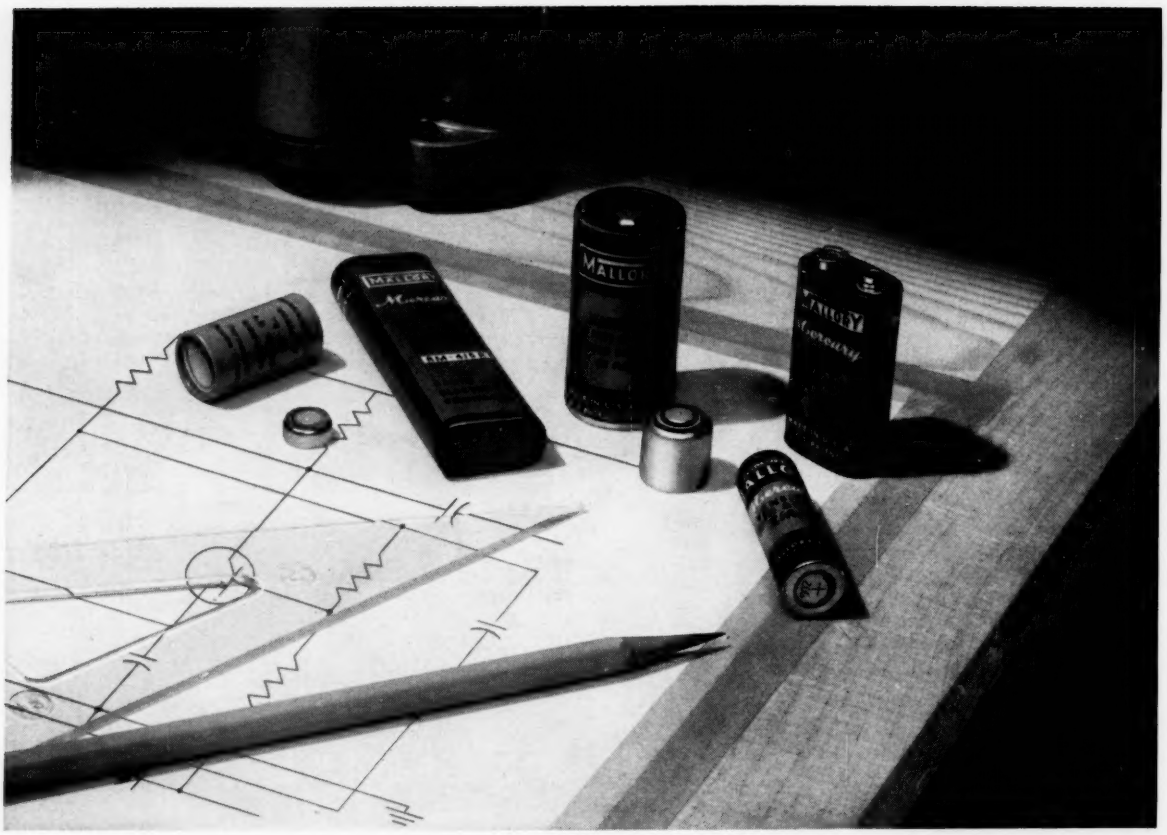

Design for extra sales features

...with Mallory Mercury Batteries

When you plan new battery-powered products, give them the extra features that spell sales success—by designing around Mallory Mercury Batteries. These unique batteries, pioneered and perfected by Mallory, are a key component in many of today's brightest new electronic products . . . transistor radios, alarm systems, portable instruments, pocket tape recorders.

Design for miniature size. Tiny Mallory Mercury Batteries put a lot of energy into minimum volume. The battery is no longer the limiting bulk component in your designs.

Design for user convenience. Mallory Mercury Batteries outlast ordinary batteries *several times*—both in service and in storage. Nuisance of frequent battery replacement is ended. Cost per hour is low.

Design for user satisfaction. This battery sets a new standard of performance. Its constant discharge provides fade-free operation, exactly matches transistor requirements. Its voltage is amply accurate for use as a reference in many instrument and bias circuits. Its rugged design withstands extremes of temperature and humidity.

Write to Mallory today for data on the complete range of ratings and sizes, and for engineering assistance on your specific applications.

Parts distributors in all major cities stock Mallory standard components for your convenience.

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P. R. MALLORY & CO. Inc., INDIANAPOLIS 6, INDIANA

Parts distributors in all major cities stock Mallory standard components for your convenience.

Serving Industry with These Products:

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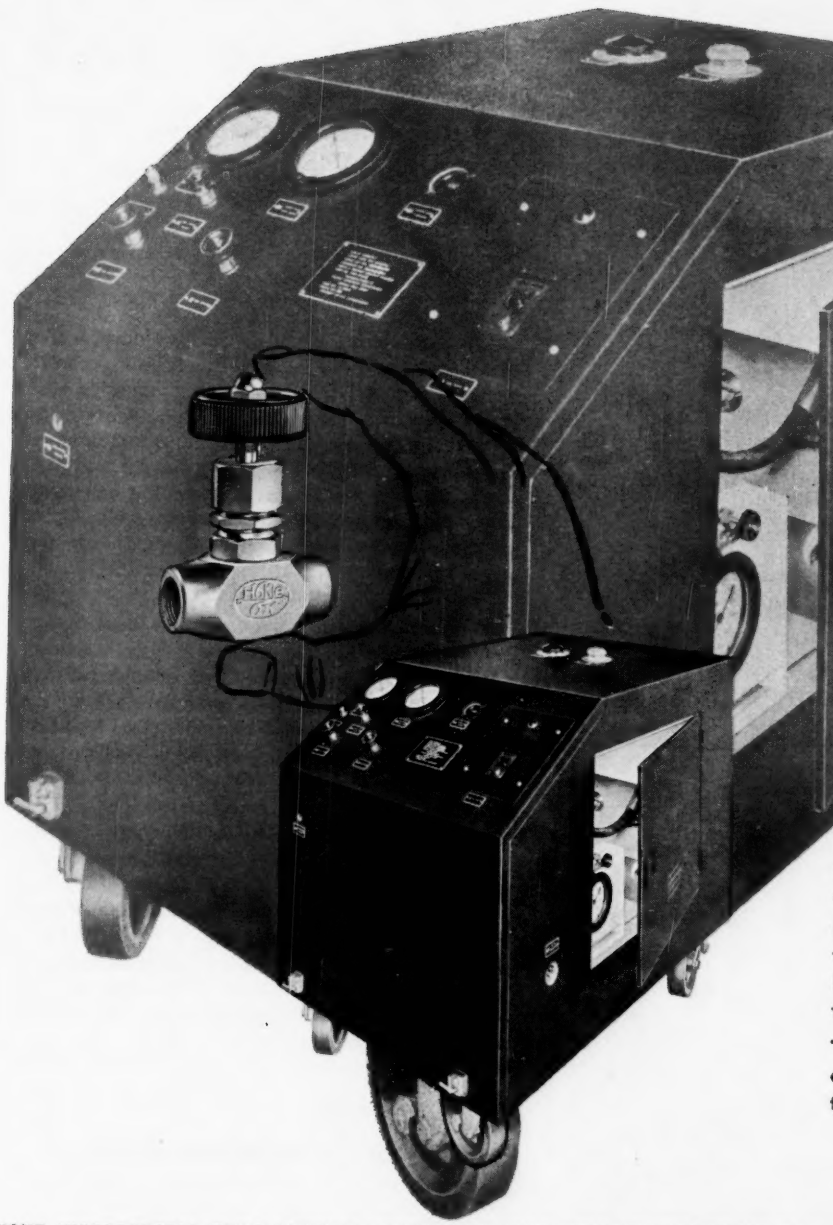
small valves are judged by the company they keep



Anyone who has had experience with jet fuel will tell you how difficult it is to seal in. Like alcohol in your car radiator, it'll find a way out where water won't—and a favorite spot is the valve packing. Most valves shy away from "keeping company" with jet fuel . . . but not Hoke's 270 Series needle valve with O-ring stem seal. Flight Support Incorporated of Linden, N. J., uses five of them to handle the elusive material as it passes through their Model TE-7001 Portable Static Fluid Test Machine. The equipment checks fuel system components on turbo-jet engines.

Thanks to the resiliency of the O-ring and the accuracy of the machined bonnet into which it fits, Flight Support found the 270 Series to be best for their use . . . not a pound of pressure nor an ounce of fluid gets by!

Checking out jet engines is pretty fast company for small valves . . . that's why producers of high quality test and production equipment have often turned to Hoke for valves that measure up to such strict dependability requirements. Users, too, recognize the craftsmanship in Hoke's valves, and look for them on the equipment they buy.

There's more to the Hoke story in our new catalog (MV-957). It's yours for the asking.

HOKE, INCORPORATED, FLUID CONTROL SPECIALISTS, 189 S. DEAN ST., ENGLEWOOD, N. J.

OK

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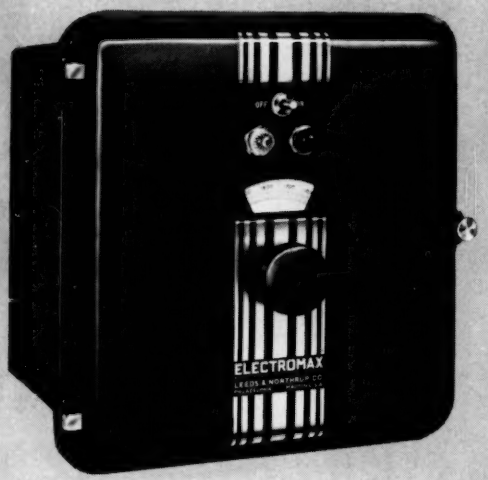
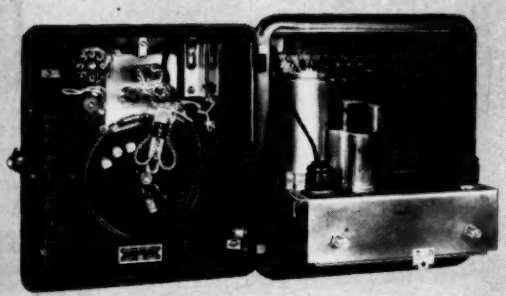
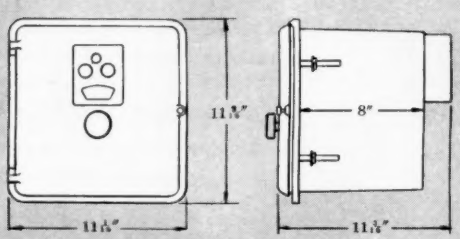
NEW





Design simplicity minimizes maintenance; sturdy components resist normal shock and vibration. Precisely calibrated slidewire and circuit resistors hold stability. For easy servicing, amplifier slides out of case; standard vacuum tubes are used . . . their replacement requires no special selection.



Compact Electromax controller mounts flush in panel. Leads are brought to terminal board located on back of case. Net weight about 27 pounds.

Thermocouple Electromax® Controller for temperatures up to 3200 F

- ***0.3% LIMIT OF ERROR***
- ***10 μV* CONTROL DEAD BAND***
- ***CONTINUOUS STANDARDIZATION***
- ***4-WEEK DELIVERY***

**0.5 F for base metal thermocouples; approximately 1.5 F for platinum thermocouples.*

Combining all the accuracy and reliability of a modified d-c potentiometer with a drift-free amplifier detector, this new Electromax signalling controller provides low-cost electronic two-position control where a record or continuous indication is not required. It's ideal for many electric and fuel-fired furnaces, ovens, plastic extruding machines, and some types of chemical processing units. Other uses include zone control on continuous ovens and kilns, and excess (overheat) temperature cutout control.

This compact signalling controller has only two moving parts—a plug-in relay and converter (chopper). These, together with simple circuitry and liberal use of plug-in components (including a plug-in amplifier), minimize maintenance and reduce initial cost. To speed start up of your process, Electromax is delivered four weeks after receipt of your order.

Other standard features include both thermocouple and amplifier fail-safe, and automatic reference junction compensation. Amber and red signal lights indicate whether process temperature is above or below set point.

For additional information on the thermocouple Electromax, call your nearest L&N office or write 4955 Stenton Ave., Philadelphia 44, Pa. Ask for Preliminary Data Sheet ND47-33(1).

LEEDS Instruments **NORTHRUP** Automatic Controls • Furnaces

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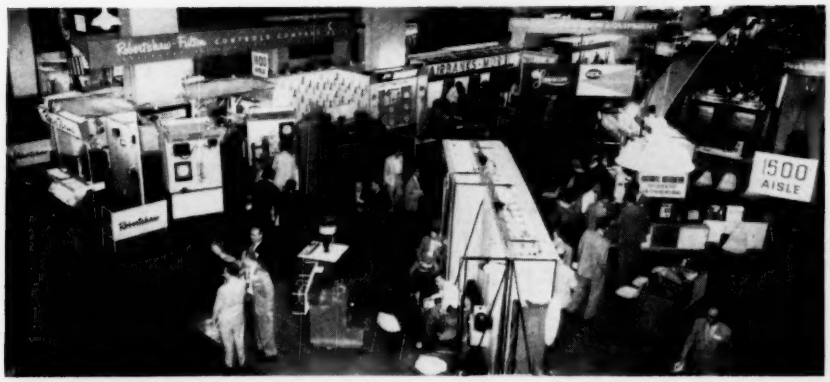
12th ISA Show



Editorial

THE 12th Annual ISA Conference and Exhibit (Cleveland, Sept. 9-13) was dedicated to a concept, the Systems Concept, even to the rather extreme extent of abandoning its heretofore powerful technical program in favor of a group of papers on the subjects of systems engineering and computers in control. As no clear picture of either the applicability or feasibility of the concept* emerged from this program, our show report this year will, of necessity, be devoted to the new instruments displayed.

These new instruments remain as the important news of our industry. Even though many are inclined today to reject one small new instrument as an unglamorous subject, even though a new digital computer must today be introduced as a "Digital Process Control Computer," the field of measurement and control rests on a firm foundation of small, widely applicable, individual instruments. Inasmuch as data-handling systems, miniaturization, transistorization and chromatography can no longer be considered news, the year's progress in instrumentation is reflected in the following listing of exciting new instruments seen by your editors at the show. (The reader is referred to the August issue of *I&A* for 126 other new Instruments unveiled at the show.)

It is no accident that the list is headed with one of the smallest instruments in one of the smallest exhibits in a remote corner of the vast exhibit hall. No crowds gathered around this small mechanical device, as they did around the Electronic Process Control Digital Computer. But until the working plant instrument engineer learns to use simple methods for curve analysis and Fourier-series and power-series and least-square curve fitting, the application of computers in closed process control loops will remain but an exciting possibility—for the future.

* The Systems Engineering Concept will be thoroughly analyzed in a special issue of *Instruments & Automation* (the January, 1958 issue) now in preparation. Don't miss this issue.

DATA HANDLING AND COMPUTING

Datareaders, plus GraphAnalogues and Equameters, simply and mechanically scan any number of curves, correct for zero, linearize curves, apply automatic scale factors, and perform Fourier- or power-series analysis. —Gerber Scientific Instrument Co., 162 State St., Hartford, Conn. **601**

Type 099 DataReducer produces punch cards, tape, etc., from analog-type curves.—Telecomputing, Data Reduction Systems, 12838 Saticoy St., N. Hollywood, Calif. **602**

Advanced data-handling system for process industries features a "digital potentiometer"—an analog-digital converter using a potentiometer that compares the unknown against fixed binary voltages. Accuracy is 0.1% —Minneapolis-Honeywell Regulator Co., Ind. Div., Phila. 44, Pa. **603**

GEDA M-160 Electronic Multiplier produces 5 products of up to 3 independent variables.—Goodyear Aircraft Corp., Dept. 913, Akron 15, Ohio. **604**

Digital Recorder Unit DR-704/711 accepts digital data at 40,000 data words per sec and prepares tape for direct entry into digital recorders.—Epsco, Inc., 588 Commonwealth Ave., Boston 15, Mass. **605**

Series 1200 data logger features pinboard programming.—Fischer & Porter Co., Hatboro, Pa. **606**

Model 905 digital tape handler features speeds up to 75 inches per second and 3 millisecond start-stop time.—Potter Instrument Co., Inc., 115 Cutter Mill Rd., Great Neck, N. Y. **607**

10-speed digital tape transport features 10 speeds between 1.5 and 90 inches/sec.—Electrodata Div., Burroughs, 460 Sierra Madre Villa, Pasadena, Calif. **608**

DADIT (Dependable Analog-Digital Integrating Translator) features independent analog and digital sections, carrier-type operational amplifiers and digital resolution of 1 part in 10,000; analog resolution of 1 microvolt or 0.02 microampere.—Daystrom Systems, 5640 La Jolla Blvd., LaJolla, Calif. **609**

Digital pressure recording system (Type 5770) performs analog-to-digital conversion, linearizes signal, and automatically changes range.—Systems Div., Beckman Instruments Inc., Richmond 3, Calif. **610**

Model 25 Linear Integrator features ball-and-disc integrating mechanism.—Librascope, Inc., 808 Western Ave., Glendale, Calif. **611**

S-100 digital data processing system samples up to 100 transducers at rates up to 100/sec.—BJ Electronics, Borg-Warner Corp., P. O. Box 1679, Santa Ana, Calif. **612**

Alwac III-E data-processing system is medium-sized system that operates with automatic typewriter and punched tape; can hold 8000 words (numbers up to 9 decimal digits).—Alwac Corp., 13040 S. Cerise Ave., Hawthorne, Calif. **613**

Scanner-type data printer prints at rate of 3 lines per second.—Taller & Cooper, Inc., 75 Front St., Brooklyn, N. Y. **614**

RW-300 digital computer is slanted to process control applications.—Ramo-Wooldridge Corp., Los Angeles 45, Calif. **615**

Teledata long-range data transmitter-receiver operates with punched paper tape.—Friden Calculating Machine Co., Commercials Controls Corp., Rochester 2, N. Y. **616**

CONCERNED WITH HIGH TEMPERATURE?

Look at this new flight-test oscillograph–

CEC's new 5-122 operates in a temperature range of −65°F to +250°F at altitudes to 120,000 feet. Twenty-six channels (plus two static reference traces) can be recorded. The 5-122 also meets the challenge of minimum size, consists of three small, separate modules – oscillograph and magazine, master timing unit, and control unit. Both the control and master timing units can be installed in remote locations.

Other features include new jump-speed selection method, flash timing, and improved automatic record-identification systems; explosion-proofing in accordance with military specifications; crash-resistant magazine; and provisions for synchronizing the 5-122 into an over-all data-acquisition system. Compact size is 11″ wide by 8″ high by 18½″ long. Weight is 80 lbs. fully loaded, 55 lbs. without magazine. Power requirements: 200 volts, 400 cycle, 3 phase. Contact your nearby CEC field office, or write for Bulletin CEC 1585-X5.

. . . and 7 new high-temperature galvanometers

Another important *first* in flight-test recording is CEC's new family of High-Temperature Galvanometers. Accuracy is guaranteed in ambient temperatures to 250°F for extended periods with a flat response from 0 to 3000 cps.

Consolidated Electrodynamics

300 North Sierra Madre Villa, Pasadena, California

OFFICES IN PRINCIPAL CITIES THROUGHOUT THE WORLD

For more information circle **51** on inquiry card.

EDITORIAL—CONTINUED

RECORDERS

Model 1012 36-channel direct-recording Visicorder can record to 3000 cps and makes recording immediately visible.—Heiland Div., Minneapolis-Honeywell, Denver 22, Colo. 617

Flash-processing of multi-channel recording oscillograph records can be performed by DATARITE, which can be attached to any CEC Type 5-119 recording oscillograph, giving writing speeds to 30,000 inches per second with immediate records.—Consolidated Electrodynamics Corp., 300 N. Sierra Madre Villa, Pasadena, Calif. 618

Trend recorder prints number representing peak of a curve—of importance to peak-type measurements as in chromatography.—Beckman Instruments, Inc., Process Inst. Div., 2500 Fullerton, Rd., Fullerton, Calif. 619

M Series Strip-Chart potentiometer recorders are tubeless, use transistors.—West Instrument Corp., 4363 W. Montrose Ave., Chicago 41, Ill. 620

Transistorized line of recorders, and a transistorized tank field gaging system were unveiled by—Texas Instruments, Inc., 6000 Lemmon Ave., Dallas 9, Texas. 621

Series 8000 electronic null-balance potentiometer recorder joins family of process-control instruments.—Wheelco, Barber Colman, Rockford, Ill. 622

Dynamaster recorder is now available in X-Y model.—The Bristol Co., Waterbury 20, Conn. 623

PROCESS INSTRUMENTATION

Desiccant dryer is reactivated without heat (a real "first") yet provides dewpoints to −140° F. Uses vapor-pressure principles to reactivate desiccant.—Trinity Equipment Corp., Roselle Pk., N. J. 624

Chromomax stream analyzer uses vapor-phase chromatography on 8 or 10 points.—Leeds & Northrup Co., 4955 Stenton Ave., Phila. 44, Pa. 625

Model M-12 Viscometer of Norcross can now be used for monitoring viscosity in continuous-flow applications, for first time.—Norcross Corp., 247 Newtonville Ave., Newton 58, Mass. 626

Performance Monitor detects input heat rate, monitors net output and efficiency of combustion, extracts square root, and monitors entire performance of a combustion process.—Bailey Meter Co., Cleveland 10, Ohio. 627

Magnetic flowmeter is completely obstructionless.—Fischer & Porter Co., Hatboro, Pa. 628

Industrial manostat using Cartesian-diver principle can control vacuum or pressure within 0.1% or 0.1 mm.—Hoke-Manostat Corp., 148 S. Dean St., Englewood, N. J. 629

EIL Titromatic Analyzer performs automatic, unattended titrations and detects end points.—Robertshaw-Fulton Controls Co., Instr. Div., 2920 N. 4 St., Phila. 33, Pa. 630

Model 184 Vapor Fractometer extends gas chromatography technique to continuous process stream analysis.—Perkin-Elmer Corp., Norwalk, Conn. 631

Electro-caloric flowmeter was exhibited by—Instrument Development Labs., Inc. 17 Pollock Ave., Jersey City 5, N. J. 632

Dissolved oxygen recorder uses principle new to USA.—The Hays Corp., Michigan City, Ind. 633

Anemometer (manometer) cell for measuring very low gas flow (less than 50 ml/min) uses two filaments in diffusion cavities in wheatstone bridge circuit.—Gow-Mac Instrument Co., 100 Kings Rd., Madison, N. J. 634

Complete new control line of control equipments, including Type MMP (Magnetic Modulator Positioning 3-mode control system, all electric) and MMC (Magnetic Modulator Current with output to drive magnetic amplifiers).—Wheelco, Barber Colman Co., Rockford, Ill. 635

Temperature controller (thermistor) and a new proximity detector were unveiled by—Autron Engineering, Inc., 1254 W. 6 St., Los Angeles, Calif. 636

Potentiometer transmitter has novel circuitry with only 1 tube.—Manning, Maxwell & Moore, Inc., Stratford, Conn. 637

Valve positioning, and any remote shaft positioning, now can be done digitally via coded-disc techniques and frequency-code data transmission.—Bendix Pacific Division, Bendix Aviation, N. Hollywood, Calif. 638

Time-of-flight mass spectrometer Model 12-100 can scan spectrum from mass 1 to mass 600 at rates up to 10,000 per second, permitting mixtures of up to 36 organic compounds to be identified.—Bendix Pacific Div., Bendix Aviation, N. Hollywood, Calif. 639

Electrodeless conductivity indicating system Type RS works on magnetic induction in range 20 kc to 70 kc.—Industrial Instruments, Inc., 89 Commerce Rd., Cedar Grove, N. J. 640

Bellows flowmeter is added to line of flowmeters.—Foxboro Co., Foxboro, Mass. 641

Bellows flowmeter is added to line of flowmeters.—Minneapolis-Honeywell, Ind. Div., Phila. 44, Pa. 642

MEDICAL

Coulter counter measures particle content and size distribution in solutions with solids in suspension. Gives 10-point size distribution and works on principle of change in electrical conductivity as solution passes through orifice.—Coulter Industrial Sales Co., P.O. Box 212, Elmhurst, Ill. 643

Kay-Cross Oxygenator exposes a film of blood to oxygen atmosphere on a series of rotating discs.—Pemco, Inc., 5663 Brecksville Rd., Cleveland 31, Ohio. 644

Vibrating-capacitor pH measuring unit has accuracy to 0.002 pH—of extreme importance to medical field.—Robertshaw-Fulton Controls Co., Inst. Div., 2920 N. 4 St., Phila. 33, Pa. 645

Human-heart-action analyzer of Decker Aviation was considered outstanding novelty by many vistors.—Decker Aviation, 1361 Frankford Ave., Phila., Pa. 646

OF GENERAL INTEREST

Polaroid technique makes projection slide instantly and on the spot, at a cost of only 55 cents per slide—permits instant projection of curves, models, etc.—Polaroid Corp., Cambridge 39, Mass. 647

High-speed commutator Series 25-1100 accepts inputs from 100 pickups and samples at rate of 30,000 samples per second.—Wiancko Eng. Co., 255 N, Halsted Ave. Pasadena 8, Calif. 648

CAT—Confirmed Automatic Traffic-control—system provides complete control of traffic on multilane roads from a central control point, using two wires and multiplex technique.—Taller & Cooper, Inc., 75 Front St., Brooklyn 1, N. Y. 649

Remote positioning system is fail-safe—shaft will either stay in last position or move to any predetermined position in event of system failure.—The Bristol Co., Waterbury 20, Conn. 650

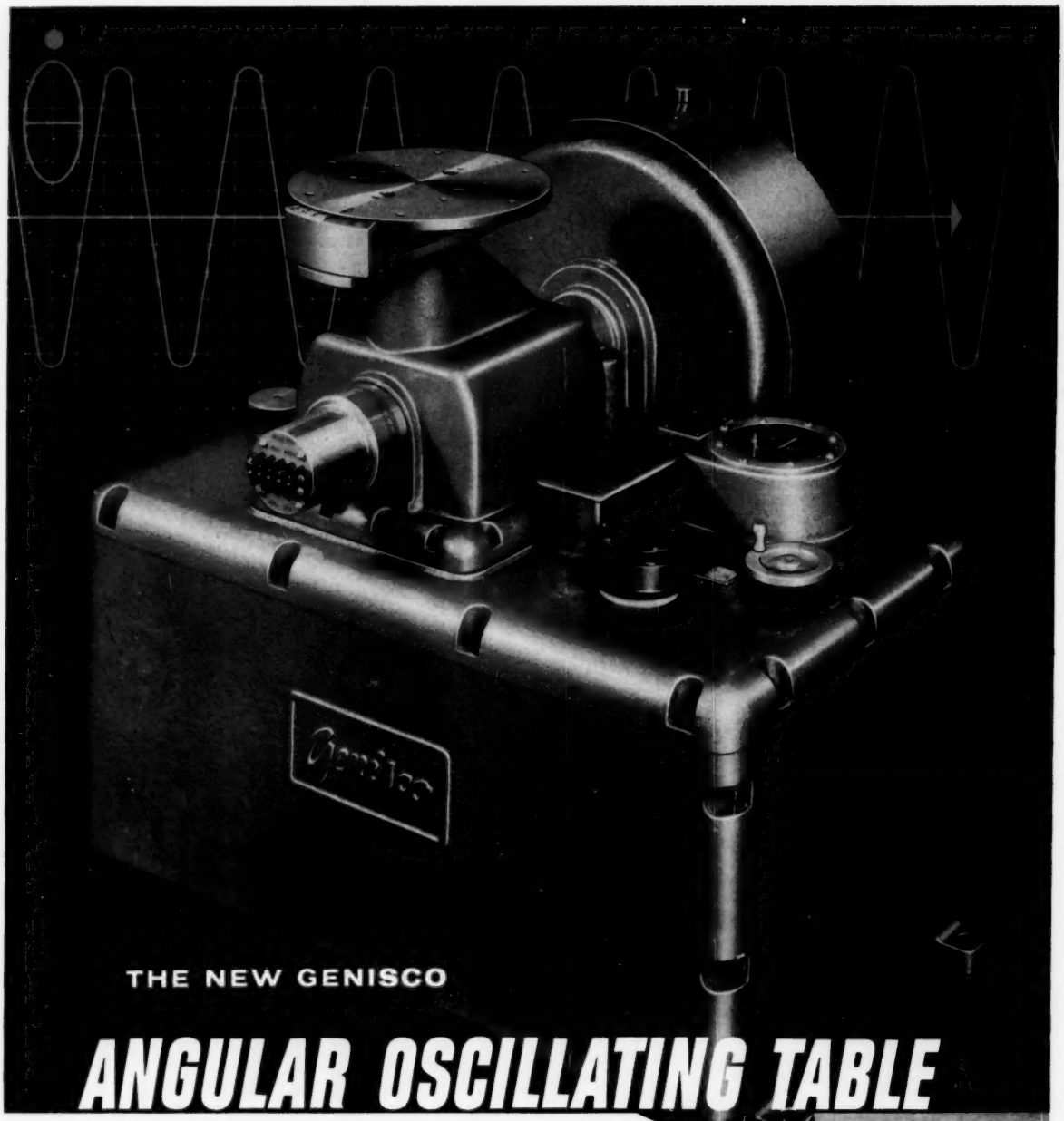
NMR—Nuclear magnetic resonance analyzer—can measure total moisture content of material in ½ minute to 0.1%.—Schlumberger Well Surveying Corp., Ridgefield, Conn. 651

TP-625 Frequency Analyzer determines frequency and amplitude of all components of a complex wave in range 2-25,000 cps. Resolution is 2 cps; includes servo drive.—Technical Products Co., Instr. Div., 6670 Lexington Ave., Los Angeles, Calif. 652

Servo ratio multimeter that measures AC/DC ratios, absolute AC/DC voltages and resistance was unveiled by—Union Switch & Signal Co., Pittsburgh 18, Pa. 653

Wayne-Kerr Universal Bridge Type B-221 measures impedance and admittance via a transformer ratio-arm bridge.—Robertshaw-Fulton Controls Co., Instr. Div., 2920 N. 4 St., Phila. 33, Pa. 654

Center-tapped miniature Syncroverter chopper can be used as a polar relay, differential relay, in push-pull circuits, flip-flop circuits, etc.—The Bristol Co., Waterbury 20, Conn. 655



THE NEW GENISCO

ANGULAR OSCILLATING TABLE

Generates a precise sinusoidal function accurate to within 0.1% at excursions up to ±2°, 0.5% up to ±10°, and 1% up to ±15°.

This newest Genisco machine utilizes a unique conical crank mechanism to generate an angular oscillation which closely corresponds to a theoretical sinusoidal waveform. A precision sine-cosine resolver coupled to the crankshaft can be used to bring a test instrument output signal and the oscillating table output signal into coincidence for direct reading of phase lag angle.

The extreme accuracy of the Model B386 Oscillating Table makes it particularly suited for evaluating the damping and response characteristics of angular accelerometers and rate gyros. The Model B386 can also be used for calibrating peak angular velocities and peak accelerations to the accuracy of the known angular excursion and frequency. Within its range, the machine can double as an environmental angular shake table.

For complete information and performance specifications, write to–

Brief specifications

Angular Excursion: Infinitely adjustable from zero to ±15°.

Frequency Range: Continuously variable from 0.02 to 3 cps in the low range; 0.2 to 30 cps in the high range.

Accuracy:
Angular Excursion—within 10 minutes of arc.
Frequency Indication—within 1% with tachometer; within 0.1% with stroboscope.

Payload Capacity: 100 lb. deadweight; 750 lb.-in. under dynamic conditions. Protected against dynamic overload by replaceable shear pins.

Vibration Isolation:
Vertical Displacement—0.003" max. at any frequency
Lateral Displacement—0.001" max. at any frequency.

Platform Diameter: 8".

Approx. Weight: 400 lb.

Genisco
INCORPORATED

2233 FEDERAL AVE., LOS ANGELES 64, CALIFORNIA

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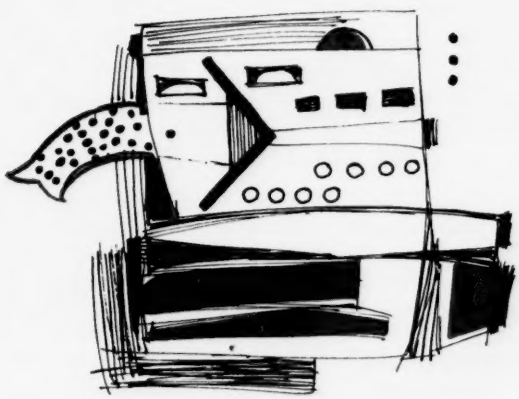
To all readers of INSTRUMENTS AND AUTOMATION



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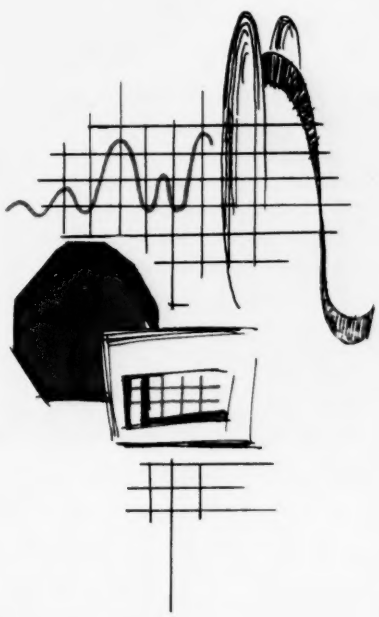

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Electronic Circuit Designer Robert G. Hildenbrandt tells why developing circuits for transistorized airborne computers at IBM Owego offers the professional challenge of a lifetime.

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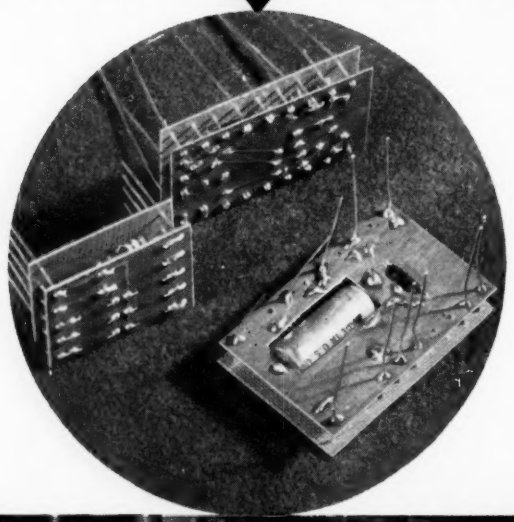

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A review of the principles of hybrid computers reveals the value of the new, fast Multiverter both as an information link and as an independent computing device. Inherent accuracy can be adjusted automatically to match the input frequency.

FIG. 1. MULTIVERTER

Hybrid Analog-Digital Computing Systems

MAX PALEVSKY, Packard-Bell Computer Corp.

THE RAPIDITY with which the field of computer applications has expanded has provided a broad field for both analog and digital techniques. One result has been a compartmentalization of thinking and skills within the two partisan groups.

Within the last year or two certain problems have arisen that have forced both sides to re-evaluate the merits of their respective techniques as neither alone appears adequate for some of the problems generated by our increasingly complex technology. As a result, a growing number of hybrid computing systems are in use, under construction or being planned.

Analog and Digital Characteristics

The reasons for constructing a hybrid system, such as that shown in Fig. 2, center around considerations of speed, accuracy, size, cost and flexibility. The accuracy of a general-purpose digital computer is limited in practice by speed alone. Analog devices, on the other hand, are limited in accuracy but operate at speeds that can be many orders higher than that of even the largest general-purpose digital computer. This speed results both from the inherent response of analog devices and from the parallel organization of analog components. In an analog computer each function is represented by a physical element or group of elements while a general-purpose digital computer employs a single arithmetic unit that is time-shared—that is, the arithmetic unit operates serially, generating each of the required functions in turn.

The parallel as opposed to the serial mode of operation also is reflected in the size and cost of the two types of computers. As the problems to be solved increase in size, the number of elements in an analog computer increases at a linear rate. On the other hand, no increase in the cost of equipment is required as the size of problems expands in a digital computer; however, the time required for computation increases so that the allowable problem size is restricted—particularly for real-time solutions.

Hybrid Systems

In a hybrid system these characteristics can complement one another to yield, in certain cases, a system unattainable by either technique alone. In a typical hybrid (Fig. 2) the analog equipment handles the relatively high-frequency variables at low accuracies, while the digital portion performs computations only upon those variables that change slowly. The performance of many dynamic systems depends to a large extent on the low-frequency phenomena so this division of labor can result in accurate over-all solutions.

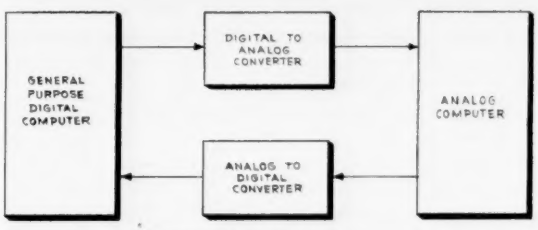


FIG. 2. TYPICAL hybrid arrangement.

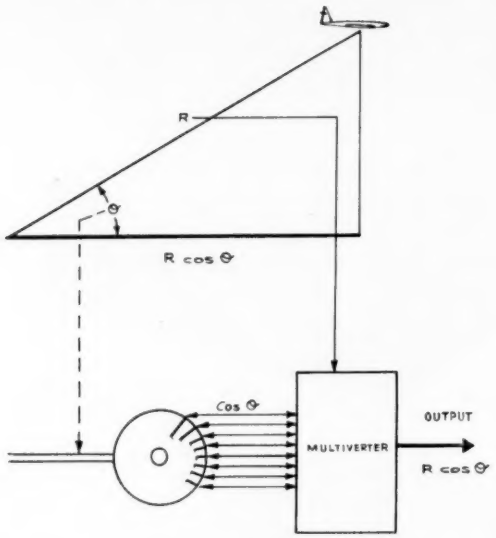


FIG. 3. MULTIVERTER PROVIDES $R\cos\theta$ output (analog) directly from R (analog) and cos θ (digital).

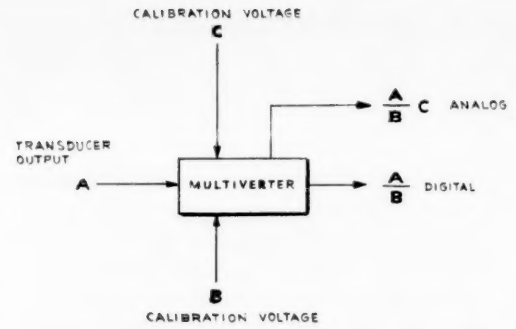


FIG. 4. DIGITAL AND ANALOG outputs can be produced simultaneously.

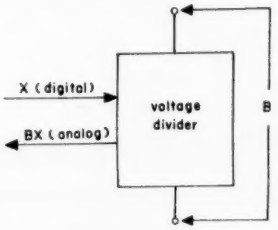


FIG. 5. DIGITALLY-CONTROLLED voltage divider is central component.

A hybrid system of this type with approximately 150 electronic amplifiers, several analog-to-digital and digital-to-analog converters, and a large-scale digital computer recently solved a complex set of airframe and control equations that would have required over 500 amplifiers if the method of solutions were entirely analog. On the other hand, perhaps 3 large-scale digital computers operating in parallel, together with a good ideal of auxiliary equipment, would have been needed to provide a wholly digital system with the requisite speed.

Function Inputs

A hybrid system can use the comp'ementary characteristics of the two types of computers for entering arbitrary and empirical functions into a computation. Arbitrary function generators that are currently in use with analog equipment, in addition to being limited in accuracy, do not give repeatable results. A statistical distribution of solutions must be generated in order to estimate the true solution—a time-consuming process. A digital computer employing either a stored table of values or a polynomial approximation, can generate functions that are both repeatable and accurate.

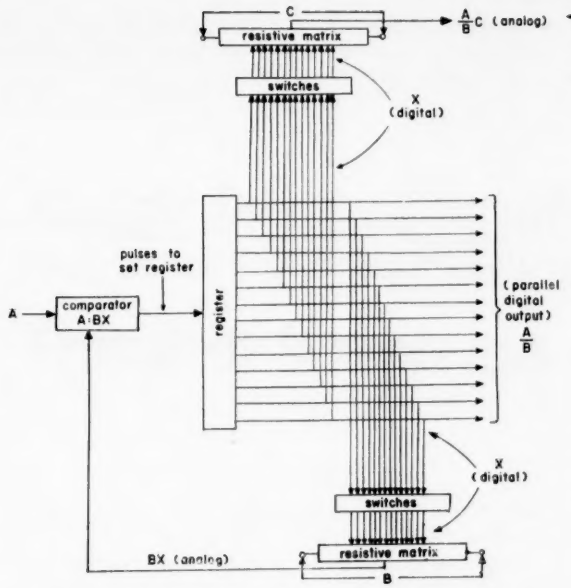
On the other hand, it is often difficult for a digital computer to deal with empirical functions, such as those generated by parts of a control system or by equipments that are part of a physical simulation, because these functions are most often generated with analog transducers. The analog portion of a hybrid system can use the analog signals directly, and, by performing preliminary computations, can often reduce the number of converters that would be required for a completely digital system.

Hybrids Involving Incremental Computers

The slow response of digital computers, the restricted accuracy of analog computers, and the degradation of information that results from conversion can be mitigated in some cases by replacing either the general-purpose computer or the analog computer by a *digital differential analyzer** (DDA or incremental computer) of sufficient speed. A computer of this type, now under development at the Packard-Bell Computer Corporation, is capable of performing 100,000 iterations of an entire system of equations per second. Such speed permits faster solutions than those that can be realized by a general-purpose digital computer, and is comparable to the speed of an analog computer.

If such a device is employed in the place of the analog computer in Fig. 2, the converters can be eliminated. Furthermore, because incremental computation is more accurate than analog computation—particularly for nonlinear systems—a large portion of the computation can be processed outside of the general-purpose computer so that, in effect, the frequency response of the entire system is increased. This approach appears particularly appropriate for control systems where the control process can be directed by a central general-purpose computer which assigns tasks to relatively specialized peripheral computers.

*For a clear description of the principles of the DDA, see article "Digital Differential Analyzers," *I&A*, June, 1957, pages 1105-1109—Ed.



◀ **FIG. 6. CONNECTING LINES** carry analog and digital signals to computing elements.

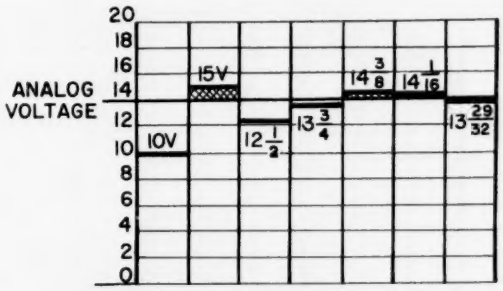


FIG. 7. FEEDBACK ENCODING. Unknown voltage (14 volts in this illustration) is compared against successive trial voltages—10 v, 5 v, 2½ v, etc., When unknown is larger than the trial voltage, the trial voltage is accumulated; when unknown is smaller than trial voltage, the previous trial increment is rejected. The result here is 1 (10) +0(5) +1(2½) +1(1¼) +0(⅝) +0(5/16) +1(5/32). Coded output (1011001) operates a set of switches in resistive matrix. As the binary point is at the left-hand end, the code is binary for 89/128 which, multiplied by 20 volts, is 13.906.

If the general-purpose digital computer of Fig. 2 is replaced by the faster incremental computer, the resulting system is smaller and has a higher frequency response than any of the systems discussed thus far. Because the increased accuracy that is available from the digital techniques may be required at only a restricted number of places within a system and, further, because it is not economic to scrap existing analog equipment that performs satisfactorily in many types of computation, a hybrid of this type is preferable in many cases.

A New Type of Hybrid

A computing system also can be hybrid in a sense that appears to be relatively new—it is possible to perform computations directly with one variable being an analog voltage and the other a digital number. For example, given a voltage representing range and a number representing the cosine of an angle (Fig. 3), it is possible to produce the resolved distance directly without converting either factor by using a device which has both analog and digital elements. The device, shown in Figs. 1 and 3, is called a *Multiverter.** Furthermore, it is possible to perform such computations at analog rates by exploiting the switching characteristics of certain transistors. Using the Multiverter, it is possible to calibrate the output, A, of a transducer by two factors B and C (Fig. 4), both of which are analog functions. Note that output A/B is a digital number and AC/B is an analog voltage.

*Trademark Packard-Bell Computer Corp.

The Multiverter

The Multiverter (Fig. 1) is a high-speed, completely transistorized, analog-to-digital, digital-to-analog conversion system which operates with better than 0.01% accuracy.

The central component is a digitally-controlled voltage divider. If a *number* X controls the divider, the output will be a *voltage* equal to the product BX, where B is the voltage across the divider (Fig. 5). If, now, the divider is employed to generate the feedback voltage for an analog-to-digital converter a quotient is formed. With X as the input voltage and B the voltage across the divider, the *number* in the register will be X/B.

The *compare* device (Fig. 6) is analogous to a chopper that alternately samples the incoming and the feedback *voltage* and emits a *pulse* that indicates the proper setting of the register digit position that is being processed. This principle of feedback or voltage-comparison encoding is standard technique and is shown in Fig. 7.

The functions of the register are:

(1) To hold the digital value of the quotient formed by the ratio of incoming voltage to reference voltage. This digital value then operates a set of switches which, in conjunction with the resistive matrix, makes up the voltage divider. The position of these switches across the resistive matrix determines the feedback voltage.

(2) The register and its control circuitry make up a system which samples the incoming voltage with the appropriately weighted feedback voltage so as to determine each of the digits in the register in turn.

In addition to the whole-number converter that has

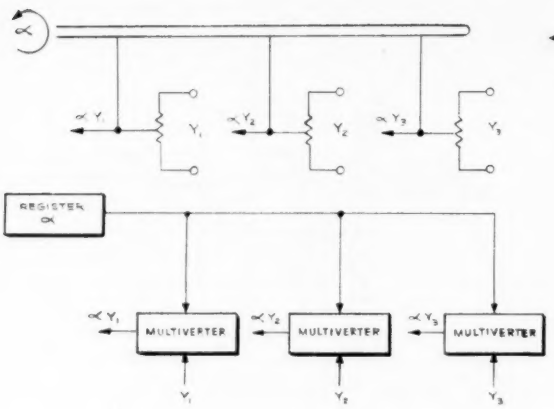


FIG. 8. ANALOG-TYPE SERVOMULTIPLIER (top) can be replaced by Multiverter (bottom) which both multiplies and converts in a single operation.

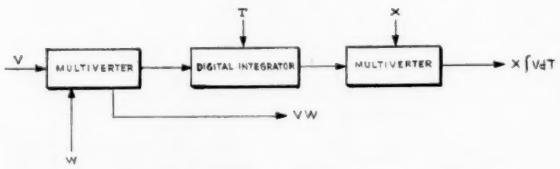


FIG. 9. APPLICATION in open-loop integration.

been described, the Multiverter also can be supplied as an incremental converter in which the register and its control circuitry are replaced by an up-down counter. Like the whole-number device, the incremental converter has 14 bits (or 4 decimal digits). Both models contain provisions for varying the number of places carried in the conversion to permit the interchange of speed and accuracy. This is particularly important in incremental conversion because a reduction of n binary places results in an increase of 2^n in speed. For example, the Model M-1 can follow a voltage which has frequency contents of up to approximately 10 cps with a precision of 14 bits. If only 10 bits are used, the frequency increases to 160 cps. Furthermore, this shift can be either preset manually or performed automatically. In the latter case the precision of conversion is automatically adjusted to yield the optimum accuracy. During periods of rapid change the counting takes place at the tenth bit; when the rate of change decreases, the counting position is shifted to the fourteenth bit to take full advantage of the accuracy of the Multiverter.

When this new conversion technique is combined with the hybrid techniques previously described, a new class of flexible computational systems becomes possible. For example, it is common practice in an analog control system to produce some of the outputs as shaft rotations and to couple to each shaft several potentiometers to effect a series of multiplications as shown in Fig. 8. When a digital computer replaces a portion of the control system, the shaft rotations are replaced by numbers in a register so that two conversions are required if the multiplication is to be performed digitally and the product is to take the form of a control voltage. If an analog multiplier is employed, a single conversion is required. The Multiverter provides for both multiplication and conversion in a single operation (Fig. 8) and performs these functions in a small space (an 11-bit converter is approximately as large as a pack of cigarettes).

Using these new techniques, open-loop integration can take the form shown in Fig. 9. The input voltage, V, which can be either a d-c analog or a modulated 400-cycle a-c analog, can be converted to a number and integrated. The result then can be reconverted to a d-c voltage multiplied by some analog variable X. The output is therefore $X\int V dt$, where t can be time or any other variable in the computation. It also is possible to generate $X\int (V/Y)\,dt$ or other products and quotients independently of, yet simultaneously with, the integration process.

Conclusion

Hybrid computation, because of its flexibility, can perform in ways that are not possible with homogeneous systems—particularly if transducers couple information into and out of the system. By considering the over-all computing configuration, including transducers, a hybrid computer permits a selection of the type and position of transducers and computations that often results in a more efficient over-all system.

The new Multiverter not only increases the flexibility possible in these hybrid systems by permitting computations in which the factors are in different representational systems, but, because of its accuracy, appreciably reduces the degradation of information during conversion. Using all of the available techniques—general-purpose digital, analog, Multiverter and high-speed incremental—it is possible to construct more efficient special-purpose systems and more flexible general-purpose installations.

SPECIFICATIONS OF STANDARD MODELS

Precision of Conversion	14 binary (4 decimal)
Selection of Precision of Conversion	
Model M-1	Manual and Automatic
Model M-2	Manual
Speed of Conversion	
Model M-1	
Analog-Digital	Counter operates at 300 kc
Digital-Analog	300,000/sec
Model M-2	
Analog-Digital	Greater than 15,000/sec
Digital-Analog	300,000/sec
Digital Output	Either parallel or serial
Input Voltage Range	20 v
Output Voltage Range	20 v
Reference Voltage Range (Voltage across voltage divider)	20 v
Physical Size	5¼" of a standard relay rack
Power Consumption	Under 10 watts
Comparator Sensitivity	Better than 50 microvolts

Analog Integrating of Transient Waveforms

This analog integrating system can supplement oscillographic recording in the study of transient phenomena and replace it where the integrated value, rather than the precise wave form, is of primary interest.

RALPH C. LEIBOWITZ, David Taylor Model Basin

IN MANY CASES where the integral of a complex wave form is being investigated oscillographic recordings are made and the trace is then integrated by a planimeter or by other means. Long delays between recording and evaluation, and sources of error, such as paper shrinkage and nonlinearity of the time base, often interfere with assessment of the records.

A need, therefore, exists for an instrument that will provide an accurate and reliable measurement of the integral of transient wave forms to supplement or replace oscillographic or other recording methods. To meet this need, an analog integrating system has been developed that measures the integral of the applied wave form and holds this value on a front panel meter long enough to allow an observer to read and record the data. The method has the following advantages:

1. Data are obtained directly in useful form without time delay. The data can be evaluated as they are gathered, and successive test programming can be modified immediately in accordance with previous results.

2. The analog integrating system is easy to use and is comparatively inexpensive.

3. The system is accurate for time integrations up to 1 minute maximum. For a 4 mv-sec pulse the errors in the integrals measured averaged 2%, with a 1.5% minimum and a 2.5% maximum error. Calibration is reliable for at least one day.

System Design

The integrating system comprises a d-c decade amplifier, a voltage divider, and a Model 1472 Weston Inductronic fluxmeter (Fig. 1).*

The fluxmeter is the unit that performs the actual integration and exhibits a direct reading of $\int e\,dt$ (where e = voltage and t = time). The reading is accurate for time integrations up to 1 minute. The full-scale reading of the fluxmeter is 5 mv-sec.

Fig. 2 shows the basic fluxmeter circuit. The desired integration is accomplished by feedback balancing through a mutual inductance (L) coupling output and input of a Weston Inductronic Amplifier. The gain of this amplifier is very large. The following equations describe the circuit operation:

$$e = -e' = -L\ di/dt$$

where e = input voltage and e′ = induced voltage. i is the output current flowing through the indicating instrument. Hence:

$$i = -(1/L) \int e\,dt$$

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*Weston Electrical Instrument Corp.

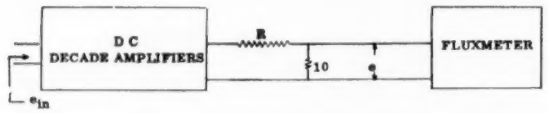


FIG. 1. SCHEMATIC diagram of the integrating system.

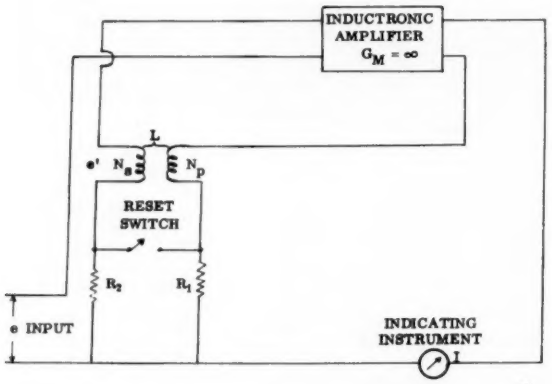


FIG. 2. BASIC CIRCUIT of Weston Model 1472 Inductronic Fluxmeter.

i is directly proportional to the integral. This method of integration follows sharply rising or falling pulses very well.

Impedance Matching

The major problem arising in any attempt to employ the fluxmeter as an integrator is that of supplying it with a low source impedance (not exceeding 50 ohms) in order to avoid excessive drift of the milliammeter needle during a 1-minute period. In many applications the source impedance exceeds 50 ohms. Even a voltage divider coupled between the source and fluxmeter, which presents an adequate impedance to the fluxmeter, introduces additional problems, such as loading the source or presenting an inadequate voltage level to the fluxmeter during the desired period of integration. For greater accuracy, amplifier gain or the voltage divider should be set so that the panel meter reading can be made near the top of the scale.

A d-c amplifier coupled through a voltage divider to the fluxmeter provides a flexible instrument that will satisfy these requirements. The most pertinent specifications of this amplifier are:

1. Response from dc through 25 kc is ± 1 db, from 25 kc to 100 kc ± 3 db, in step-controlled gains of 0, 20, 40 and 60 db. (Flat response to 5 kc would be adequate.)

2. Accuracy of gain setting, ±0.5 db at 1000 cycles.

3. Input impedance, 100,000 ohms shunted by a 75 $\mu\mu$f capacitor.

4. Hum and noise referred to input terminals at all ranges, 30 μv total and less than 15 μv due to components below 500 cycles.

5. D-c output resistance, less than 0.05 ohm in all ranges.

6. Minimum load impedance, 100 ohms.

7. Rated maximum output voltage, ±35 volts dc (or peak) open circuit.

8. Maximum rated output, ±20 ma, dc (or peak).

The instrument allows linear amplification of relatively low-level signals (millivolt range) without appreciable error because the signal-to-noise ratio is relatively large; for a 1-mv pulse applied for a 4-sec period the signal-to-noise ratio was 50/1.

Laboratory Performance

The integrating system was tested in the laboratory against secondary standards of voltage and time. A voltage pulse generated as in Fig. 3 was applied 30 to 40 times in succession. The voltage was measured against a standard cell by means of a Leeds and Northrup Type-K potentiometer. The time duration of the voltage pulse was measured on a clutch-controlled standard clock, which had been checked against a Berkeley counter. The clock is accurate to within ±0.002 sec over a 1-sec period, i.e., 0.2 percent error. The clock circuit was connected to one pole of the double-pole switch shown. The input of the integrating system was connected to the other pole of the switch. Runs were made on three separate days. For an average integral value of about 4 mv-sec, the standard deviation was found to be about 0.015.

The average percentage error varied from day to day and was of the order of 2 percent with the integrator reading lower than the standard value in every case. The fact that an average error exists introduces no complication because the average error can be eliminated by a simple adjustment of the mutual reactor in the Inductronic amplifier, or simply accounted for by multiplying each fluxmeter reading by an appropriate constant. The minimum and maximum percentage errors observed were approximately 1.5 percent and 2.5 percent, respectively. Thus the observed deviation from the average is about ± 0.5 percent. Additional tests were performed to determine whether this error was inherent in the fluxmeter or due to the closing of switch or relay contacts at slightly different times, or due to switch or relay bounce. These tests evaluated the fluxmeter itself, apart from the decade amplifier. Various types of switches were employed which closed the two circuits nearly simultaneously. Final sets of runs were made with a double-pole microswitch, the poles of which closed practically simultaneously even when closed slowly.

The results of the tests performed with the microswitch show that the average percentage error en-

countered is about 1.8 percent for each of two sets of runs performed on the same day, with a standard deviation of the order of 0.01 where the average reading is about 4 mv-sec. The following day, with the same switch and for approximately 4 mv-sec integral readings, the average percentage error was about 2.8 percent with the same standard deviation. Thus it was conclusively determined that the error was not due to differences in the closing time of the fluxmeter and timing circuits.

Application

The time integral of the voltage output of a transducer used in the static firing of rocket motors is readily obtainable and, if desired, can be verified by planimetering the recorder trace. The setup is shown in Fig. 4.

The 100,000-ohm amplifier input impedance placed across the transducer will load the circuit by only 0.1 percent; therefore, the damping of the galvanometer is unchanged. (The results obtained from the recording galvanometer would be unaffected even if the amplifier did constitute a load as the galvanometer calibration steps would be proportionately affected.)

By varying the setting of the decade resistance box and the gain of the amplifier, a very wide range of integrals can be evaluated by the fluxmeter, which reads 5 mv-sec full scale. The maximum value of e in this problem is approximately 6 mv.

When a voltage is applied about 30 times for a period of about 1 sec simultaneously to both the integrator and galvanometer systems, and the integrator data correlated against the planimetered trace data (i.e., the integral obtained from the record), the average error is of the same order of magnitude as that found in the laboratory tests. As previously noted, an adjustment can be made to eliminate this error.

Field Problems

The integrator system problems encountered in field tests were:

1. The calibration steps also are integrated. The area under these steps must be planimetered in order to obtain proper correlation of the data, or a cam can be placed on the calibrator to hold open a switch in the integrator circuit when calibration steps are applied to the oscillograph in order to avoid integrating the area under the calibration steps.

2. The fluctuating line voltage causes initial motion of the needle and a change of drift rate. This can be eliminated by use of a voltage regulator.

3. Pickup in the integrator system hookup wires causes initial motion of the needle. Shielded wire will eliminate this trouble.

4. Operator error exists in reading the fluxmeter. This can be minimized (1) by using a camera to give a permanent record of each reading, (2) by using a galvanometer recorder, instead of a meter, which will give a recorded height proportional to the integral, or (3) by a digital voltmeter which will give a visual readout.

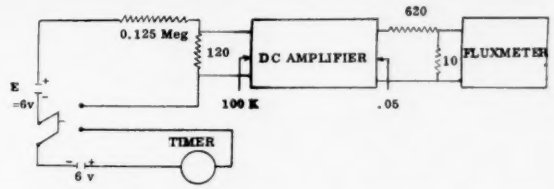


FIG. 3. SCHEMATIC diagram of laboratory test setup.

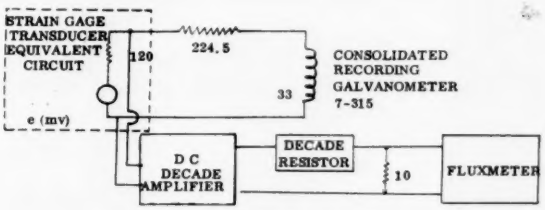


FIG. 4. A PRACTICAL field setup.

Extension of Integrating System Utility

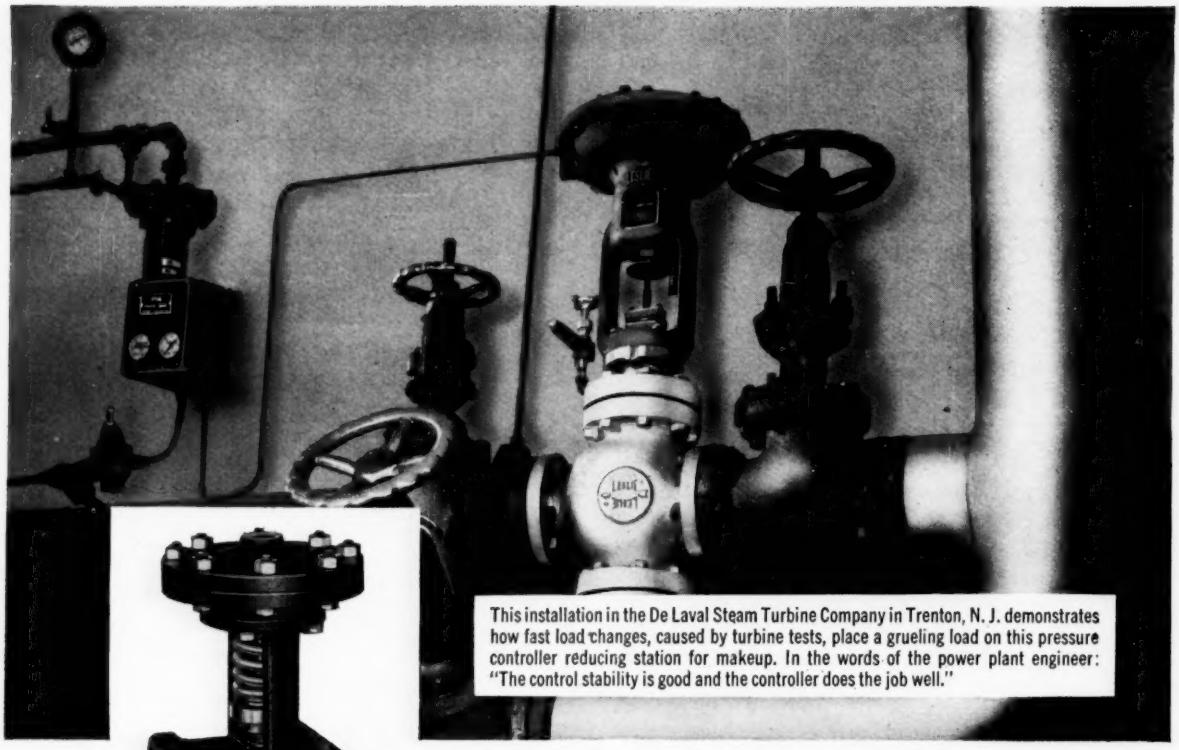
1. The integrating system can be used to obtain the integral of a transient wave form up to any given time after integration starts. In this case it is necessary to synchronize the initiation of the phenomenon with the closure of a time delay relay that is normally open.

2. The integrating system also can be used to obtain the integral of a transient wave form between two predetermined times. This can be done by a time-delay circuit which, at the appropriate time, closes a time-delay relay that is preset to open a given time later.

3. The integrating system can be used in another manner to obtain the integral of a transient wave form between any two desired times and also the sum of the integrals corresponding to any periods of times. This requires photographic techniques and timing dots, but eliminates the necessity of synchronization. In this procedure a film moves periodically and a shutter automatically opens once during each period of film rest. The developed film will give a numerical value of the integral opposite the timing dots.

Acknowledgment

The author wishes to thank Mr. William Rolnick and Mr. Nathaniel Ladson for their assistance, and Dr. Y. C. Tsao for the interest he has shown during the course of this work.



This installation in the De Laval Steam Turbine Company in Trenton, N. J. demonstrates how fast load changes, caused by turbine tests, place a grueling load on this pressure controller reducing station for makeup. In the words of the power plant engineer: "The control stability is good and the controller does the job well."

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*not directly related to process variables but resulting from pipeline friction and turbulence.

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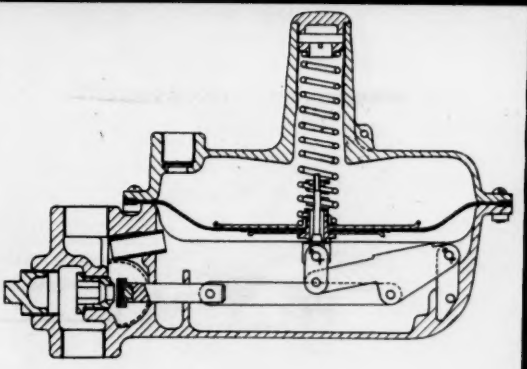

Fig. 6-1. Typical regulator for domestic gas service. Large diaphragm, lever system, and soft seat are used for positive lock-up.

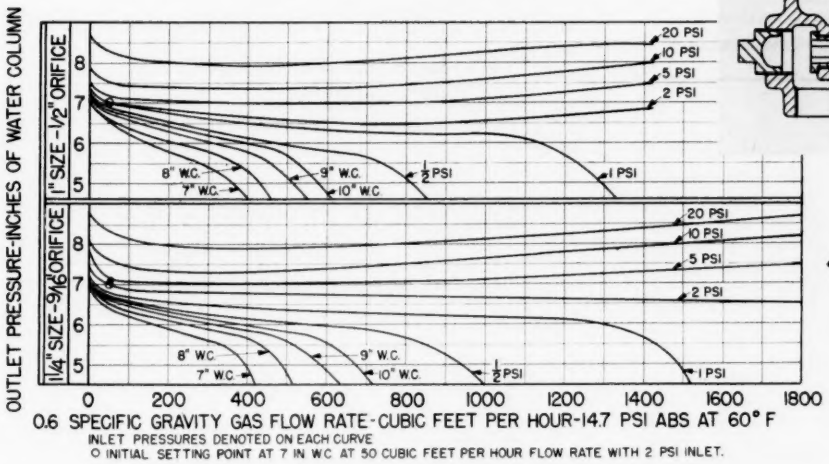
OUTLET PRESSURE-INCHES OF WATER COLUMN
1" SIZE - 1/2" ORIFICE
1/4" SIZE - 9/16" ORIFICE
20 PSI
10 PSI
5 PSI
2 PSI
1 PSI
1/2 PSI
8" W.C.
7" W.C.
9" W.C.
10" W.C.
0 200 400 600 800 1000 1200 1400 1600 1800
0.6 SPECIFIC GRAVITY GAS FLOW RATE-CUBIC FEET PER HOUR-14.7 PSI ABS AT 60° F
INLET PRESSURES DENOTED ON EACH CURVE
O INITIAL SETTING POINT AT 7 IN WC AT 50 CUBIC FEET PER HOUR FLOW RATE WITH 2 PSI INLET.

Fig. 6-2. Pressure characteristic of a regulator depends on inlet (supply) pressure. Higher inlet pressure results in better (flatter) characteristic.

REGULATORS—No. 6

Domestic Regulators

Domestic regulators reduce line pressures of 5-15 psig to the 5-8 inches WC used in household appliances. They are characterized by large diaphragms and require positive lock-up for safety reasons.

C. S. BEARD
General Controls Co.

BEFORE the advent of natural gas for domestic use, gas distribution systems were designed to handle manufactured gas, and the low pressure of the gas storage holder was sufficient to distribute gas throughout a district. This low pressure (about 10" WC*) allowed direct use in water heaters, cooking ranges and space heaters designed for low-BTU gas. Variations of a few inches in pressure did not appreciably affect the operation of the appliance, and the small number of gas-burning appliances, as well as the relatively small consumption of each one, did not cause excessive pressure drops in the house piping system.

Greater consumption of gas, particularly of natural gas, required elevating the pressures in existing systems (1) to insure proper distribution and (2), in newly designed systems, to reduce the required line sizes. Higher line pressures necessitated design of the so-called *service regulator* to deliver the low-pressure gas on which domestic appliances operate. The operational features of service regulators are rather exacting, and utility company specifications are continually calling for more refined performance.

*Water column

Operational Features of Service Regulators

Domestic regulators *must* have positive lock-up. Long periods of low or zero consumption occur in many homes. Any small leak through the seat would rapidly build up pressure in the relatively small capacity of the house piping system.

Soft seats made of leather or synthetic rubber are essential to tight shut-off. As shown in Fig. 6-1 the regulator is designed to guide the soft seat to insure contact with the entire periphery of the seat ring. Due to the low line pressures the force available to position the valve is small, and mechanical means (systems of linkages and large diaphragms) are used for positive seating.

Present-day gas appliances are designed for close control and high efficiency, but require a gas supply of constant pressure. Hence domestic regulators must control within a few tenths of an inch of water pressure, from maximum capacity to small flow. Operating pro-

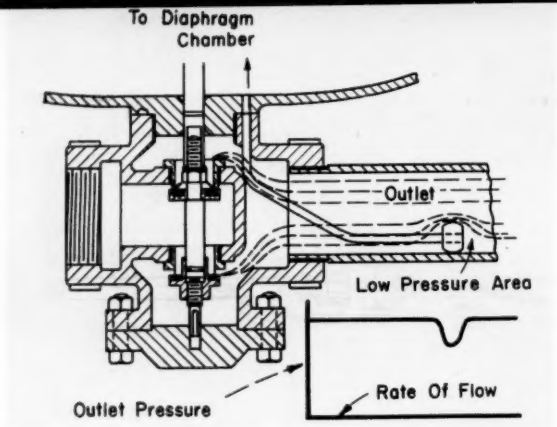

Fig. 6-3. Static restriction supplies booster effect. Obstruction in outlet line produces a low-pressure area whose pressure decreases with flow. This pressure is led by tubing shown into the diaphragm control chamber.

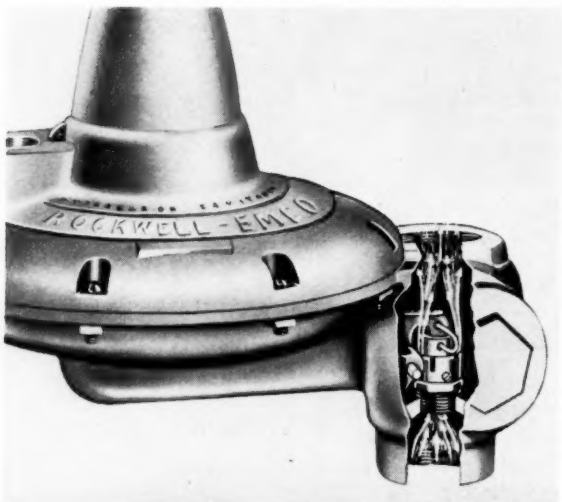

Fig. 6-5. Venturi flow pattern is formed by valve seat and disc design.

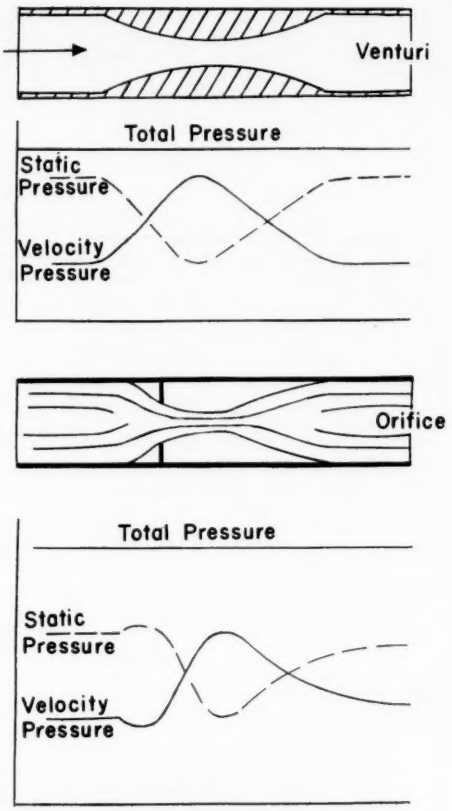

Fig. 6-4. Low static-pressure point caused by venturi or orifice can be used to give booster effect.

cedures combine to make it difficult to hold the pressure constant.

In a community, conversion from manufactured to natural gas usually requires installations of house regulators to keep the delivery pressure constant. This work should be done mostly in summer so that the newly installed regulators are not called upon to deliver peak loads. Upon completion of the conversion, the inlet pressure is usually increased, with improvement in control over a wider range of flow (Fig. 6-2).

If a community must use existing gas mains for natural gas, the pressure after conversion should be held as low as possible to minimize leakage. Distribution pressure in such situations are usually from 12" WC to about 2 psig. As maintenance or replacement of existing facilities progresses, the pressure can be increased, but usually is lowered during the low-consumption night times. The regulator is called upon to adapt itself to all these changes through a reasonable range.

In piping systems designed for higher pressures, the inlet pressures at the regulator can be as high as 35 psig. Even in such systems the inlet pressure often is varied, depending on the consumer load, so as to maintain optimum regulation conditions.

Design Features

Domestic regulators are designed to control the outlet pressure within prescribed limits despite the widely varying inlet and operating conditions discussed. This is done by use of (1) a long spring with low rate (pounds per inch), used to minimize the deviation in spring strength between the position where the valve is closed and that when it is open, (2) thin pliable diaphragms of large area, with minimum hysteresis and minimum change in effective area, and (3) mechanical advantage of linkages, to position the valve with high stability in relation to the seat for tight closure.

Increasing Outlet Pressure With Flow

The curves in Fig. 6-2 show the limitation in application of a regulator. Such flow/pressure curves are available for practically any size of domestic regulator, with recommended springs and valve seat orifices.

Another feature of most service regulators is a device for increasing the outlet pressure as flow increases. The increased pressure compensates for the larger pressure drops which occur in house piping as more appliances are put into service. One approach to gaining a "booster" effect is to provide an aspirating action into the dia-

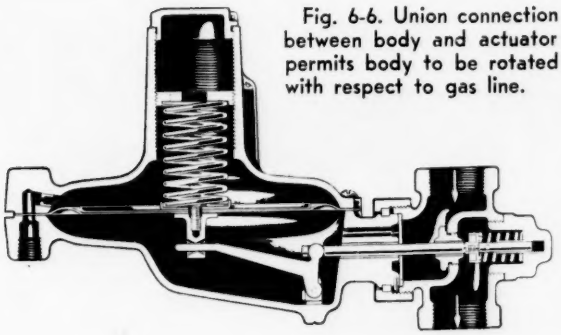

Fig. 6-6. Union connection between body and actuator permits body to be rotated with respect to gas line.

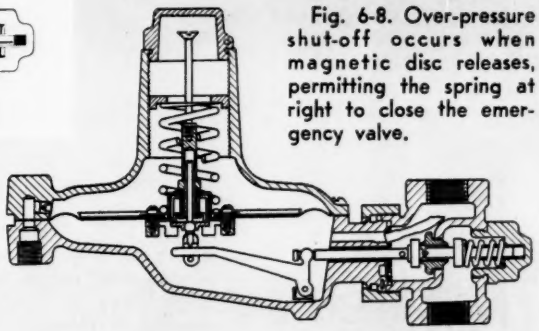

Fig. 6-8. Over-pressure shut-off occurs when magnetic disc releases, permitting the spring at right to close the emergency valve.

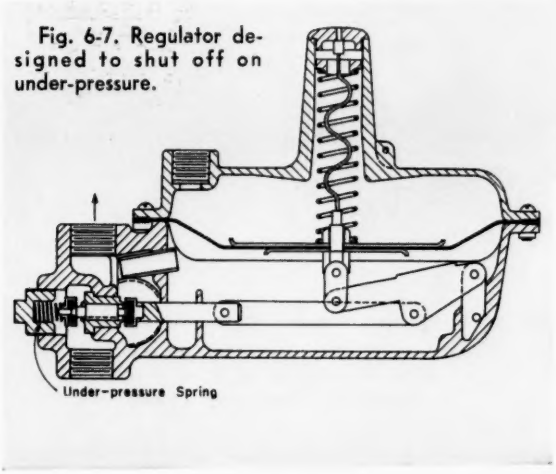

Fig. 6-7. Regulator designed to shut off on under-pressure.

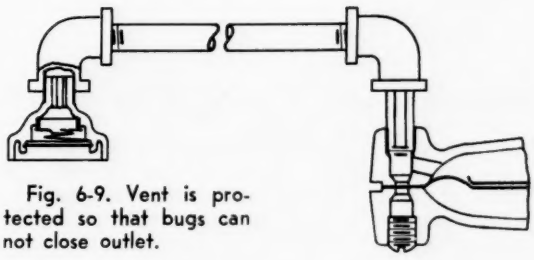

Fig. 6-9. Vent is protected so that bugs can not close outlet.

phragm chamber (see Fig. 6-1). Gas flow tends to evacuate the diaphragm chamber by a small amount which varies with flow; this reduction in pressure acts to increase the regulated pressure.

A similar effect is gained by using a static device (Fig. 6-3). As flow increases, the pressure on the downstream side of the obstruction decreases. This decreases the pressure on the diaphragm, which in turn increases the regulated downstream pressure.

Another way of obtaining the booster effect is by taking advantage of the relationship in the flow patterns and pressures following a venturi or orifice. Total pressure in a gas line is composed of static and velocity pressure (Fig. 6-4). At a restriction, the static pressure decreases upon increase in flow. The static pressure at the throat of the venturi (or the vena contracta of the orifice) can be used to control the regulator so that the discharge pressure increases with flow.

A venturi flow pattern can be obtained by use of an ejector ring, as shown in Fig. 6-5. The pressure on the diaphragm is taken from the throat of the venturi pattern created by the ejector ring; a booster effect results.

Globe-type regulators can be "boosted" by shaping a venturi throat or slight restriction just ahead of a static port leading to the diaphragm chamber, or by piping the static pressure from the vena-contracta of an orifice plate which is inserted in the downstream line.

Maintenance

An important requirement for regulators is that maintenance and replacement of parts be simple. Although the policy of many utility companies is to replace an obstreperous regulator and repair it in the shop, there are many regulator difficulties which can be remedied at the installation. Soft seats and diaphragms are the parts most likely to require attention. Most regulators are designed for easy repair.

Optional Design Features

Many optional features have been designed into domestic regulators. They are available at the discretion of the user.

Orientation of Body and Actuator

All kinds of piping mix-ups can be found under houses—especially older ones—making it imperative that the body of the regulator be mountable in any direction. This can be accomplished by a union joint between the body and the actuator (Fig. 6-6).

Emergency Shut-off Upon Loss of Supply Pressure

In the unit shown in Fig. 6-7 an additional spring on the valve on the high-pressure side causes this valve to close at extremely low pressure, when the main valve tends to open up wide. The gas then cannot reach the diaphragm chamber to reopen the valve. Reopening of the valve must be done manually by a service man who thus can make sure that all pilot lights throughout the house are lit.

Emergency Shut-off at Over-Pressure

The same auxiliary valve can be used for over-pressure shut-off. In Fig. 6-8 shut-off occurs when the

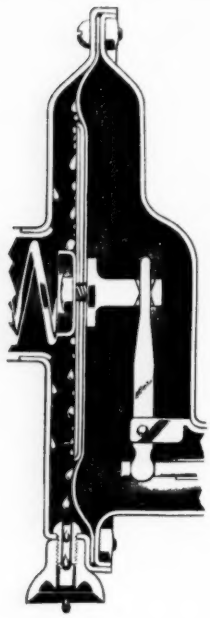

Fig. 6-10. Moisture bleed tap.

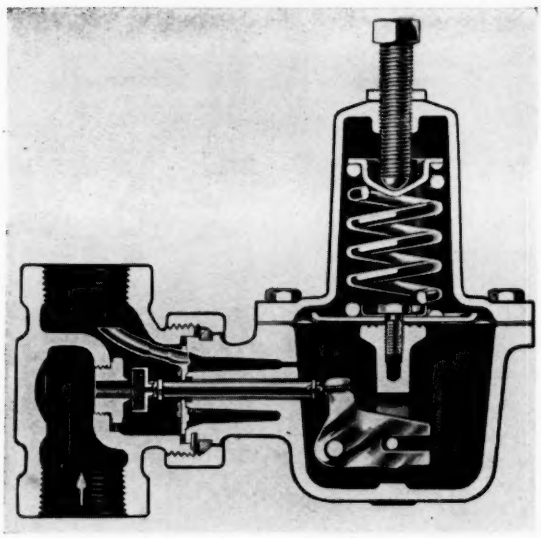

Fig. 6-11. "Farm-tap" regulator, used to supply a domestic source from high-pressure line, has smaller diaphragm.

diaphragm continues to move up beyond the available lever movement. A magnet, holding the lever to the diaphragm fitting, is pulled away and no longer holds the lever in contact with the diaphragm assembly. This allows the spring at right to close the emergency valve. The closure also can be accomplished by use of a linkage (as in Fig. 6-7) which moves the control valve under normal conditions. Upon excessive movement of the diaphragm (caused by overpressure) the linkage goes past center and reverses, pulling the emergency valve onto its seat.

Removal of Moisture from Air Side of Diaphragm

Moisture can accumulate in the diaphragm case. This moisture may not cause trouble during warm weather but can cause mal-functioning if it remains in the case and freezes during cold weather. Inasmuch as most regulators will operate in any position, a bleed can be installed at the lowest point to drain the moisture. (Fig. 6-10).

Safety Relief

Protection of the domestic gas system within a house is accomplished with a relief valve. This can be a separate valve, or it can be incorporated as part of the body or part of the diaphragm button of the regulator itself.

Venting

A diaphragm "breathes"—that is, it is slightly porous and permits a small amount of gas to penetrate with time. A vent is necessary to relieve this gas and to insure atmospheric pressure on the air side of the diaphragm. Regulators equipped with relief valves must have sufficient vent capacity to carry the relief-valve output away from the diaphragm case. In many states it is required by law to have the vent piped to a point outside the house. A weather-proof and bug-proof fixture (Fig. 6-9) can be installed at the regulator or at a remote point. As the breather valve operates on small changes of pressure it can be simply a ball or cap which lifts under pressure and falls back into place under its own weight.

Available Sizes and Types

House regulators are made in sizes from ¾" to 2". When the required consumption exceeds the capacity of the 2" size, a type of regulator other than the service regulator is indicated.

House regulators are available for use on so-called "farm taps" (Fig. 6-11) for inlet pressures as high as 400 psig. The term "farm tap" is used to designate a domestic service taken directly off a transmission line.

Most service regulators are of the types discussed and are used to reduce pressure from an inlet pressure of 5 to 15 psig to an outlet pressure of 5" to 8" WC.

Delivery of gas to the domestic regulator or to the end point of use requires a large variety of control valves and regulators, used in combination with each other in innumerable ways, defying classification. In many cases the design of equipment by one manufacturer makes it possible for him to solve a problem of gas control in an altogether different way than that of his competitor. The gas engineer may take a pilot valve from one manufacturer, a check valve from another, and a balanced line valve from still another to come up with the combination that solves his problem.

Photo Credits

Illustrations are by courtesy of Reliance Regulator Co., Chaplin Fulton Co., Rockwell Manufacturing Co., Fisher Governor Co., and Universal Controls Corp.

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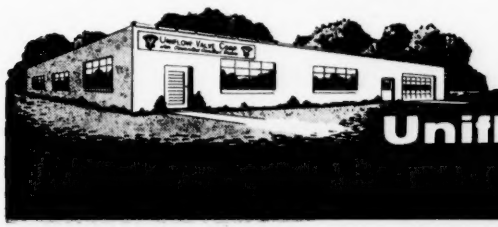

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FINDING NATURAL FREQUENCY QUICKLY

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KNOWLEDGE of undamped natural frequency (ω_n) is necessary for specifying system performance in terms of bandwidth, and gives an estimate of the speed of response.

This method for finding ω_n is based on the fact that many feedback control systems can be approximated by an integrator cascaded with a first-order lag, where the time constant of the lag (T) is the dominant time-constant of the system. Fig. 1 is the block diagram of such an approximated system; K is the loop gain of the system.

For any system which can be adequately represented by Fig. 1, ω_n can be found as follows:

$$\frac{C(s)}{R(s)} = \frac{K/s\ (Ts + 1)}{1 + K/s\ (Ts + 1)}$$

$$= \frac{K}{Ts^2 + s + K}$$

$$= \frac{K/T}{s^2 + s/T + K/T} \quad (1)$$

By comparing the denominator of equation (1) with the characteristic equation of a second-order system, we see that:

$$s^2 + s/T + K/T = s^2 + 2\zeta\ \omega_n s + \omega_n^2 \quad (2)$$

From equation (2) it follows that $\omega_n = \sqrt{K/T}$ (3)

Fig. 2 is a nomogram for the solution of equation (3). The range of K is from 10 to 100 sec^{-1} and T ranges from 0.1 to 10 sec; the resulting values of ω_n will fall between 1 and 31.6 rad/sec. By judicious use of powers of 10 and the A and B indexes on the T scale it is possible to extend the range of the nomogram to any values of K and T whatsoever.

It must be remembered that this method gives only an approximate value of ω_n for preliminary work; it does not eliminate exact analysis.

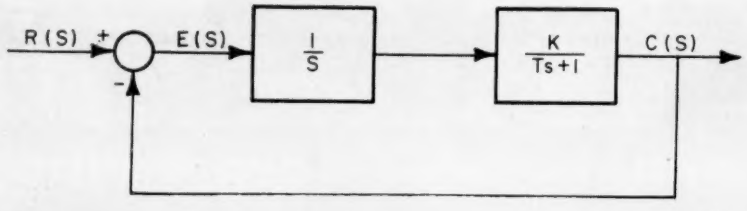
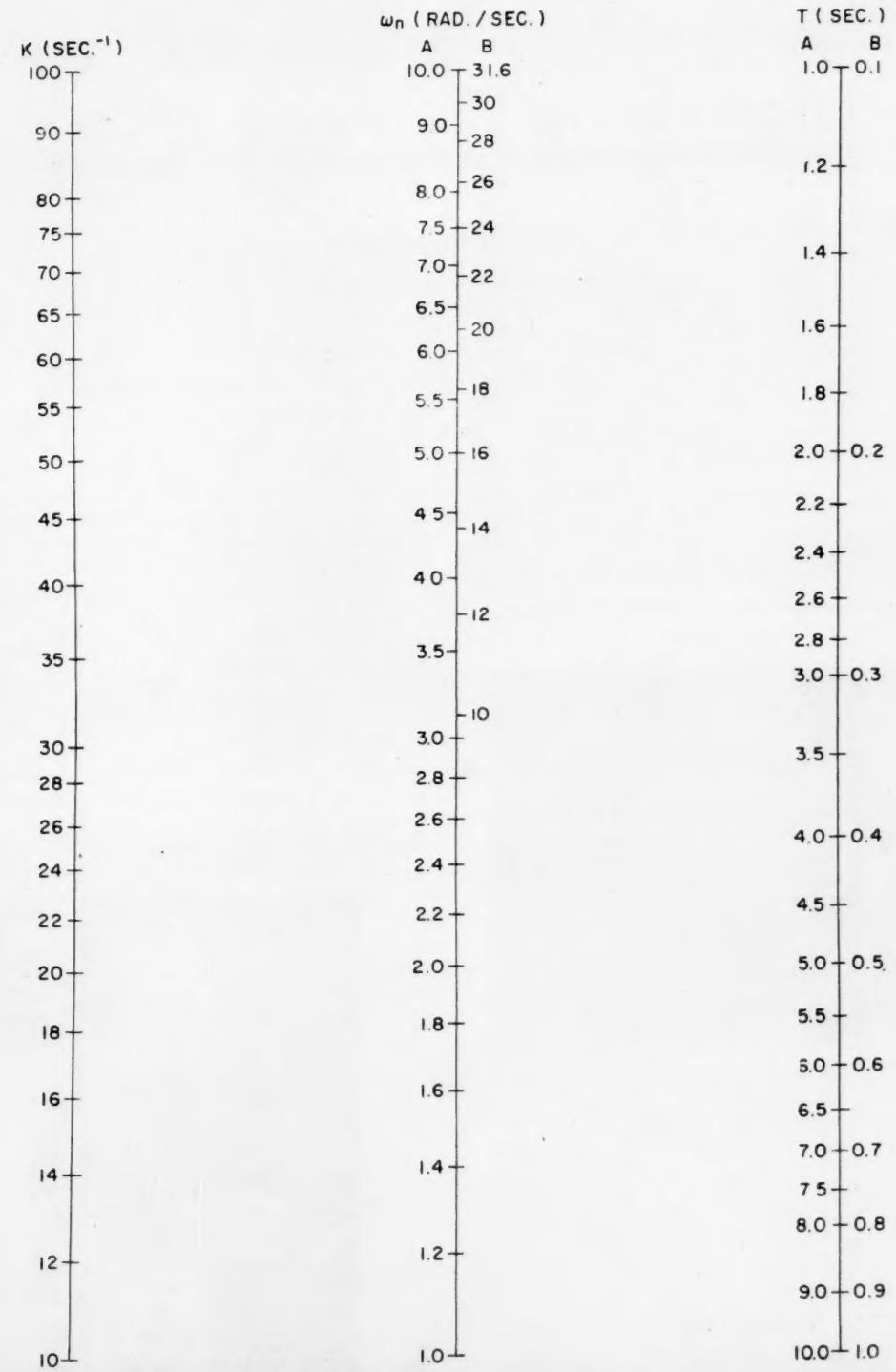


Fig. 1. Block diagram of approximated system.

Fig. 2. Nomogram for solution of $\omega_n = \sqrt{K/T}$



Engineering ITV Applications

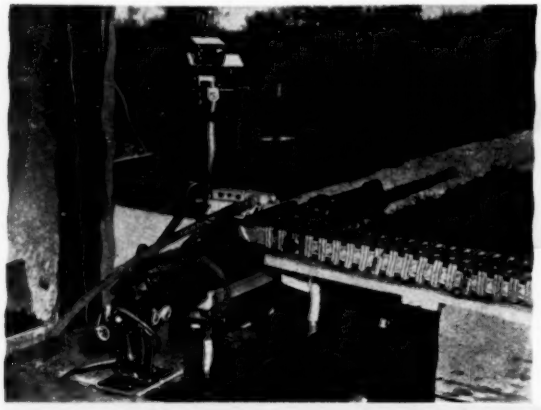
JOSEPH W. BELCHER

General Precision Laboratory

USE of industrial and institutional television is being accelerated as suppliers' enlarged experience in solving optical, lighting, transmission, packaging, control and display problems brings exciting new applications to business and industry. Most purchases involve systems, or packages, rather than simple units, and suppliers are prepared to furnish engineering service as an important part of their system package.

Optical and Lighting

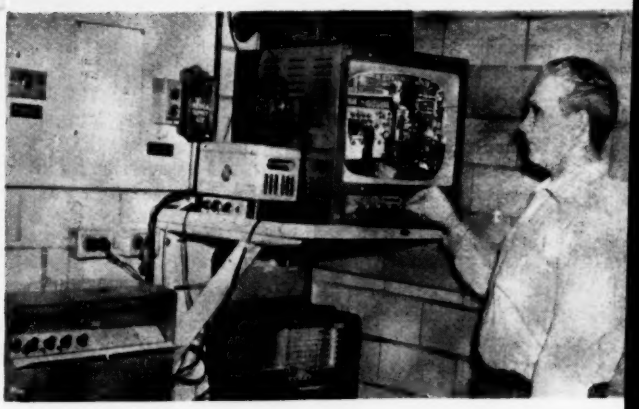
Layout and planning engineering begins with obtaining the field coverage of the lens for the vidicon tube. This tube is used to sense the image and has a slightly larger useable picture area than 16-mm film —the rectangle having a diagonal of 0.625". To obtain the focal length of the lens to be employed, the engineer divides one-half the distance from the camera tube to the subject by the width of the object, or desired scene.



RUGGED TELEVISION CAMERA, mounted on stand inside test chamber, observes weapons firing at Weapons Department of Naval Aviation Ordnance Test Station, Chincoteague, Va. Pictures of weapons performance are projected on a movie-size screen for ease and safety in viewing.
("Official Photograph, U.S. Navy")

FIVE-POUND TELEVISION CAMERA mounted on mobile cart peers through glass window into children's therapy room at recently opened Nebraska Psychiatric Institute in Omaha.

BOLTED TO THE UNDERSIDE OF a test car's front bumper is a closed-circuit TV camera which "observes" action of the car's suspension system. The picture from the camera, now used by General Motors Engineering Staff at GM Technical Center, appears on a monitor screen in the back seat of the car, where an engineer can observe it. Used for the first time in this type of testing, the TV camera gives engineers quick answers that ordinarily would take longer with motion pictures.



SHIFT FOREMAN AT ESSO RESEARCH and Engineering Company pilot plant at Bayway, New Jersey, checks safety of workmen on job at unit 300 feet away via GPL closed-circuit television system.

The vidicon sensitivity to light leaves something to be desired. Also, *f*-stops are calibrated at infinity focus and effective aperture is smaller when the camera is close to the object being viewed. Therefore, fast lenses are used. Special optics with lenses down to *f* 0.7 can be furnished for operations such as fluoroscopy or night surveillance of large areas where light is limited.

A well designed, well maintained system will reproduce elements 1/500 of picture width. For example, a large piece of steel with a small crack might have to be viewed in appropriate sections, rather than as a whole, in order to optically magnify the defect to a width capable of being reproduced. Similarly, for absolute legibility of printed material, the vertical height of a letter should occupy approximately 6 horizontal lines. The letter E is an excellent example to remember in this respect.

The "lag" or memory of the vidicon is long enough to result in a blurred image of moving objects—particularly where the detail to be inspected is small. Larger objects stand slightly faster motion. The speed of train activity in freight classification yards presents a typical case of this type. The introduction of proper techniques has permitted freight trains previously restricted to 5-8 mph to increase speed to 15-25 mph.

Handbooks supplied by lamp manufacturers provide reliable instructions for lighting. It must be remembered, however, that a flat, well-illuminated scene will not televise as well as one with lower over-all light level but higher contrast ratios—because the vidicon prefers scenes with 20- or 30-1 contrast ratios.

Transmission

The type of transmission depends on the distances involved and whether the signal is transmitted at video level or as a modulated r-f signal. For distances up to 2000 ft., commercially-available coaxial cable can be used. For longer distances it is necessary to space amplifiers throughout the cable to correct for high-frequency losses and deliver a noise-free signal. For distances beyond 5 miles, or where installations are separated by property over which the cable cannot pass, transmission may take the form of a privately owned microwave system, or leased telephone company facilities.

Presentation

Presentation may be on a television receiver or monitor, where pictures up to 27" are satisfactory. Monitors are more rugged and provide better resolution when video signals are used. Since there is no provision for sound in monitors, it is often advantageous to use TV receivers. Other units will project bright pictures up to 25 ft. wide for public displays, conferences, sales meetings, classrooms or auditoriums.

Economies have been realized by standardizing wall mounting boxes, junction boxes, and housings. Users are finding improved value service from special housings that protect the camera from explosive vapors or natural elements, and mounting pedestals that provide remote control of panning and tilting. Pedestals can be operated by radio relay-link, direct-wire or multichannel control and are available with position indicating meters.

ELECTRONIC

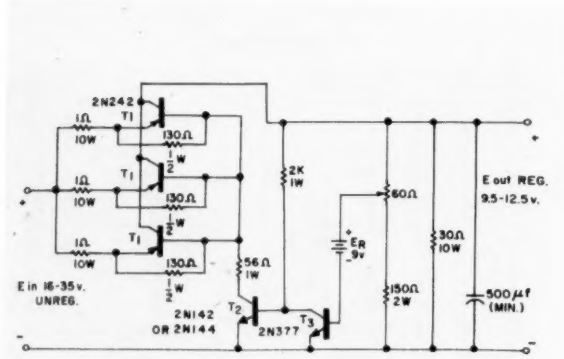
CHARLES F. KEZER
Digitronics Corp.
and
MILTON H. ARONSON
Instruments & Automation

TRANSISTOR VOLTAGE REGULATOR DELIVERS 6-AMPERE CURRENT AT 10 ±0.005 VOLTS

Three power transistors are connected in parallel in this series voltage-regulator circuit to provide total current capacity of 6 amperes at 9.5-12.5 volts, within 0.05%. To understand the principle of operation, suppose that a change in load (or input voltage) produces a rise in output voltage. The base voltage of transistor T_3 (obtained from the output via the 60-ohm potentiometer and the reference battery E_R) rises in potential, causing T_3 to conduct more current. The corresponding drop in collector potential of T_3 reduces the base current of T_2; the corresponding reduction in T_2 collector current reduces the current flowing in the base circuit of transistors T_1. Accordingly, the current through transistors T_1 decreases, and the collector-to-emitter voltage drop across T_1 increases, tending to restore the output voltage to its original value. The reverse process takes place for a decrease in output voltage.

The 1-ohm series resistors in the emitter circuits of transistors T_1 equalize the currents of the three transistors. Without these resistors, the transistor having the lowest impedance would pass most of the load current, resulting in overheating and possible damage to the transistor.

Base-to-emitter stabilization is provided by the 130-ohm resistors; these stabilize transistors T_1 for operation at elevated temperatures. Stable operation was obtained for case temperature (heat sink) at 55° C; at this temperature the circuit was unstable and would not regulate properly when these resistors were removed. Voltage regulation for changes in load current is also improved by emitter-to-base stabilization.



Output voltage may be adjusted with the 60-ohm potentiometer. Operation over a different range of voltages may be obtained by changing the voltage reference E_R to a different value. The reference voltage battery should have a service life equal to its shelf life because the current drain is only in the order of 100 microamperes.

A Zener reference diode can be substituted for the battery; when a Sylvania type 1N200 silicon junction diode was used, the regulation from no-load (0-ampere) to 4.5-ampere load current was 0.25%, compared with 0.15% with the battery.

Response time of the circuit was measured with output voltage set for 11 v, by switching load current from zero to 4.5 amperes at a 120-cps rate, and observing voltage transients on an oscilloscope. Response time was taken as the time for the output voltage to come within 5 millivolts of its final value. Response time of the circuit was about 400 usec; increasing the capacitor across the output to 3000 uf reduced the response time to 250 usec.

The 56-ohm resistor in the collector circuit of T_2 reduces the dissipation of T_2 when the circuit is initially turned on. Until the circuit begins to regulate, the collector current in T_2 runs at several hundred milliamperes which, if not limited by the 56-ohm resistor, might damage the transistor.

The 2000-ohm resistor in the collector circuit of T_3 determines the operating current level of T_3; its value was chosen to provide a current level (5 ma) at which the beta (current gain) is reasonably high. Decreasing the value of the 2K resistor was found to increase the response time of the regulator circuit; this results from the increase in storage time for transistor T_3 with increased collector current.

The circuit is made less sensitive to transistor leakage currents by the 30-ohm bleeder resistor across the output. This resistor can be safely increased to 60 ohms, making an additional 150 ma of load current available.

If a regulator circuit requiring less output current capacity is needed, a single 2N242 transistor, or two in parallel may be used. The emitter-to-base stabilizing resistors of T_1 (130 ohms in diagram) should be reduced to 39 ohms for a single transistor, or 82 ohms each for two in parallel. The 1-ohm series resistor is not needed with a single series transistor.

Input voltage range: 16-35 v dc from unregulated supply with 10% ripple (at load current of 3 amperes) and a regulation of 60% from 0 to 3 amperes.

Output voltage: Adjustable from 9.5-12.5 v dc.

Maximum load current: 6 amps dc.

Regulation against input voltage change: With no external load, variation in output voltage was 0.05% as input voltage was varied over 16-35 v dc range.

Regulation against load change: 0.15% change in output voltage when load current is changed from 0 to 4.5 amperes.

Response time: 400 usec from 0 to 4.5 amperes with 500 uf across output; 250 usec with 3000 uf across output.

Ripple reduction factor: over 2,000.

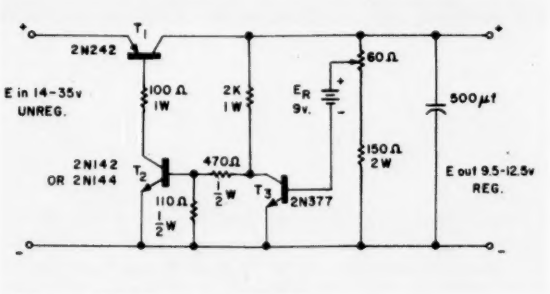
Source: W. Senges, Semiconductor Engineering Laboratory, Sylvania Electric Products, Inc., 100 Sylvan Road, Woburn, Mass.

CIRCUITRY

The circuit is the heart of all electronics. Here are 4 more basic and interesting circuits. Unless marked, resistors are in ohms, capacitors in microfarads.

TRANSISTOR VOLTAGE REGULATOR DELIVERS 2 AMPERES AT 10 ±0.015 VOLTS

This circuit is similar to the preceding one, and transistors can be paralleled to increase current capacity. Less current flows in collector of T_2 than in preceding circuit because there is no stabilizing resistor from emitter to base in this circuit, and all this current flows in base circuit of T_1.

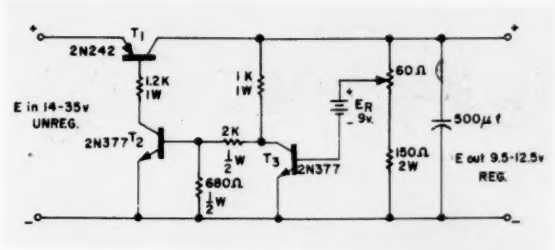


Input: 14-35 v, unregulated.
Output: 9.5-12.5 v.
Maximum load: 2 amps dc.
Regulation against input voltage change from 14-35 v: Better than 0.05%.
Regulation against load change: 0.15% from no load to 1.5 amps; 0.30% from no load to 3.0 amps.
Response time: 170 usec with 500 uf across output; 270 usec with two transistors in parallel.
Ripple reduction factor: above 2000.
Source: W. Senges, Semiconductor Engineering Laboratory, Sylvania Electric Products, Inc., 100 Sylvan Rd., Woburn, Mass.

0.5 AMP TRANSISTORIZED SERIES REGULATOR FEATURES FAST RESPONSE

This circuit is similar to the preceding two circuits, but a 2N377 transistor (T_2) with high alpha cut-off frequency is used instead of power transistor (2N142) types used in the preceding circuit. This decreased the response time of the circuit to 20 usec.

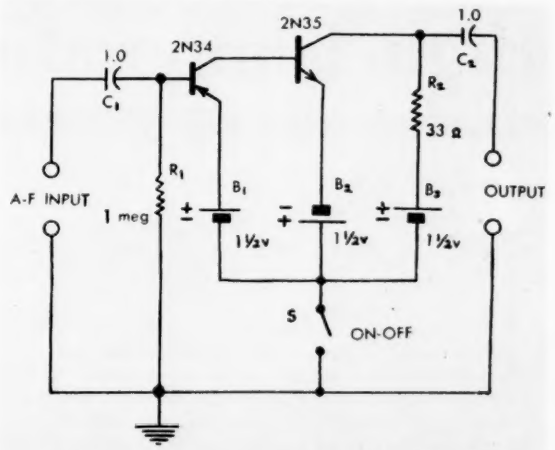
Input: 14-35 v unregulated,



Output: 9.5-12.5 regulated, 0 to 0.5 ampere.
Regulation against input voltage change: 0.10%.
Regulation against load change: 0.10% from no load to 0.5 amp.
Ripple: Too small to measure.
Response time: 20 usec.
Source: W. Senges, Semiconductor Engineering Laboratory, Sylvania Electric Products, Inc., 100 Sylvan Rd., Woburn, Mass.

DIRECT-COUPLED PNP-NPN TRANSISTOR AMPLIFIER

The opposite action of PNP and NPN type junction transistors is used in this circuit to obtain direct coupling without the need for any interstage coupling impedance. A type 2N34 PNP transistor is used in the first stage. Battery B_1 biases the emitter positive with respect to the base, and battery B_2 (via the emitter-to-base



path of the NPN type 2N35) biases the collector negatively. As bias polarities and direction of current flow in the NPN type transistor are opposite to those of the PNP type, collector current of the first stage flows in the base circuit of the second stage.

As the circuit consists of two common-emitter stages, and as each reverses signal polarity, there is no over-all polarity reversal, and output signal is in-phase with the input.

Voltage gain was measured at no-load, using a signal generator having 600-ohm output impedance.

Voltage gain: 29.5 at 1000 cps.
Maximum undistorted output: 2.1 v rms.
Input impedance: 5200 ohms.
Frequency response: Less than 1 db down at 50 cps, 3 db down at 10,000 cps. Frequency response may be extended to dc by dispensing with coupling capacitors.
Source: Booklet 28 *Uses for Junction Transistors*, Sylvania electric Products, Inc., 1740 Broadway, New York 19, N. Y.

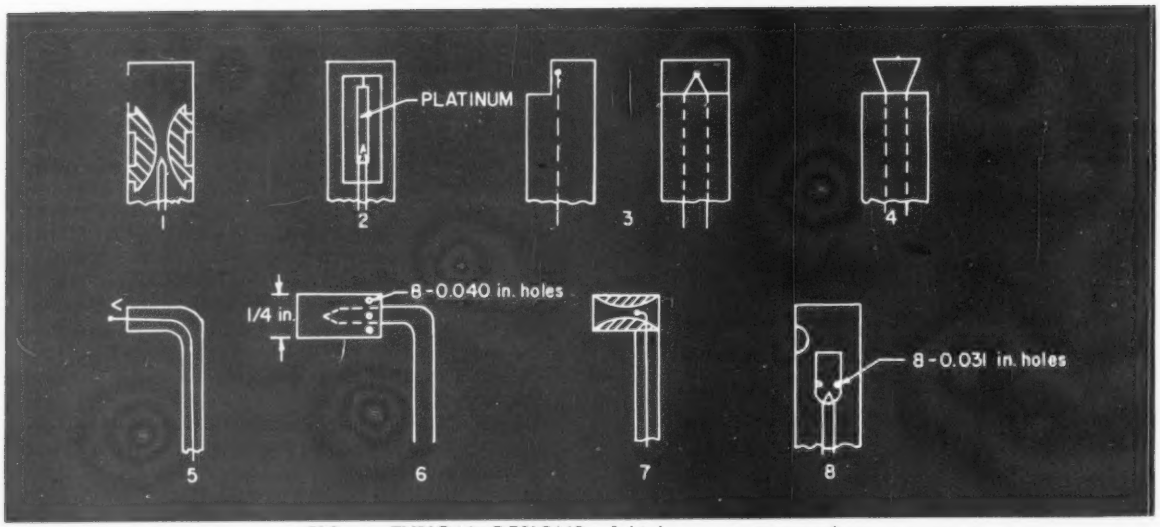


FIG. 1. TYPICAL DESIGNS of high-temperature probes.

High-Temperature Measurements

GAS temperature measurements in the liner, nozzle diaphragm, turbine, and afterburner do not normally require accuracies of a few degrees, but the high temperatures and high gas velocities offer problems which make turbomachinery measurements difficult.

At present there is an urgent need for a probe or device which will measure total gas temperatures up to 3500°F. The device must: (1) Respond to temperature only, (2) be suitable for recording and control, (3) be adaptable to flight measurements as well as test cell operation, (4) have a reasonable life expectancy. The most useful device would measure a point temperature; however, one that measures an average temperature also would be of value.

Current Practice

Gas temperatures above 1800°F are measured directly or indirectly by various means, each with its peculiarities and limitations. One author lists over 50 methods which have been used, but none meets the rigid specifications which are required for use in turbomachinery. The state of the art has not progressed rapidly within the last ten years, except in one field; considerable research has been conducted on performance characteristics of immersed probes by the Bureau of Standards. This research has developed formulas which allow us to determine the effects of radiation, conduction, and convection on various types of thermocouple probe designs. The thermocouple, with all its disadvantages, is at present the most useful (and frequently the only) means of measuring gas temperatures above 1200°F in turbomachinery.

A summary of advantages and limitations of several methods will help determine the types which merit further development.

Spectral Line-Reversal Method

Although this method is an excellent means of measuring gas temperature, it has these disadvantages:

1. It does not measure either true average or point temperature.
2. Salt must be added to the fuel.
3. It does not facilitate control.
4. It requires an elaborate, sensitive, optical system.

Photographic and Evapograph

Metallic temperatures can be measured by these methods, but they are not applicable for control purposes.

Gas Flow Through Orifice

The pressure drop across an orifice is directly proportional to absolute temperature. But the problems of cool-

H. M. BEEDE
Small Aircraft Engine Dept.
General Electric Company

Measurement of temperature of a gas stream in turbomachinery has been a challenge since the advent of the supercharger and jet engine. This article describes the problems associated with measurement of high temperature gas, and recommends a development program.

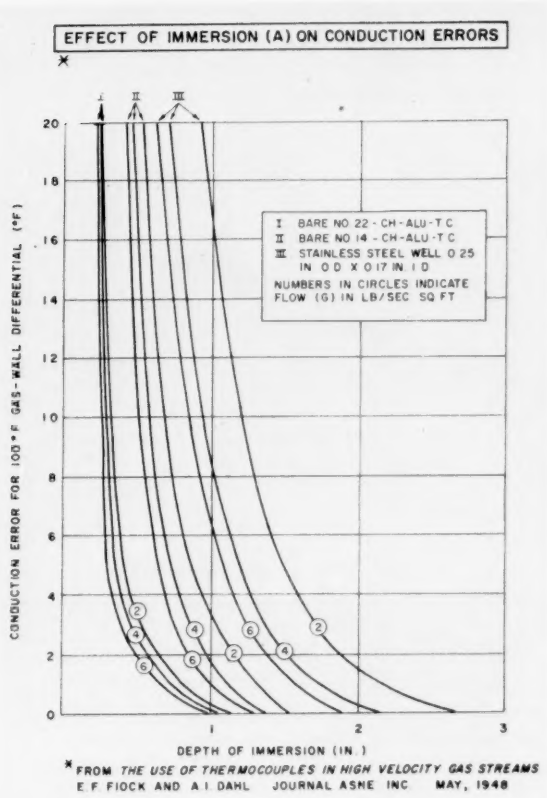

EFFECT OF IMMERSION (A) ON CONDUCTION ERRORS
CONDUCTION ERROR FOR 100°F GAS-WALL DIFFERENTIAL (°F)
DEPTH OF IMMERSION (IN.)
I BARE NO 22 - CH-ALU-T C
II BARE NO 14 - CH-ALU-T C
III STAINLESS STEEL WELL 0 25 IN O D X 0 17 IN I D
NUMBERS IN CIRCLES INDICATE FLOW (G) IN LB/SEC SQ FT
* FROM THE USE OF THERMOCOUPLES IN HIGH VELOCITY GAS STREAMS
E F FIOCK AND A I DAHL JOURNAL ASME INC MAY, 1948

FIG. 2. Immersion effect.

ing the orifice and preventing blocking make this method undependable.

Thermistor

The thermistor is ideal for control purposes, but it is subject to radiation and velocity effects like the thermocouple or any probe immersed in the gas stream. High-temperature thermistors, which are stable and not fragile, have not been developed. Some research is being done on this at the present time.

Two-Color Method

By measuring intensity of gas emission at two known wavelengths, temperature can be calculated by Wien's law. A method using this principle is now being worked on, and shows promising long-range possibilities.

Thermocouple

The thermocouple, with all its errors, is still the most useful instrument for measuring gas temperatures up to 3500°F. It often is the only device readily available. A properly designed thermocouple can measure temperatures to a high degree of accuracy; on the other hand, one that is improperly designed can present very misleading information. A thorough knowledge of the errors involved, and the means to minimize them, can make the thermocouple both reliable and accurate.

The following gives a breakdown of thermocouple errors, and some ways of minimizing them.

Inherent Error

Although leading manufacturers seldom sell wire which does not meet their guarantee, there have been instances where wire has not met specifications. To be certain, a section of each spool of wire should be calibrated against a standard thermocouple.

Change In Calibration

Thermocouples used at high temperature have a limited life, which is a function of wire size, gas temperature, and gas atmosphere. Thermocouples should be replaced at reasonable intervals, and used for only one immersion.

Conduction Error

This error usually can be minimized by sufficient immersion of the probe in the gas stream.

Calculations of conduction error can be made, but corrections cannot be applied. It is better to design

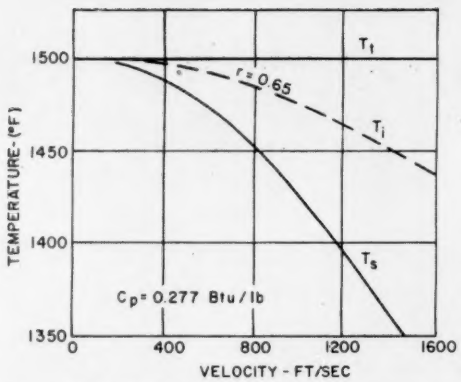


FIG. 3. RELATION BETWEEN total and static air temperature at various velocities.

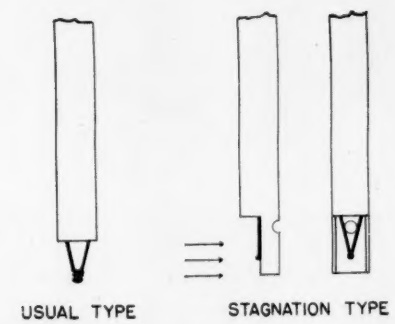


FIG. 4. VARIATION in thermocouple design to improve recovery factor.

the thermocouple in such a manner as to keep the conduction at a minimum.

Conduction error can be calculated as follows:

$$T_g - T_p = (T_g - T_s)/\cosh 2L\ (h_s/D_o K_m)^{1/2}$$

where T_g = temperature of gas at tip of probe in °F; T_p=temperature of thermocouple junction in °F; T_s= temperature of wall in °F; L=length of thermocouple wire from junction of thermocouple to ambient air in ft; h_s=surface coefficient of heat transfer in Btu/hr-ft²-°F; D_o=equivalent diameter of metallic areas in ft; K_m=thermal conductivity of probe material in Btu/hr-ft²-°F. A useful reference is shown in Fig. 2.

Radiation Error

Heat radiation from probe to walls and other solid objects can be minimized by shielding the thermocouple junction, or by using a thermocouple with low emissivity. The following formula for radiation error does not take into consideration the heat radiation from hot gases, nor from luminous flame:

$$(T_g - T_p)\ h_s = E\ (T_p^4/100 - T_w^4/100)\ 0.173$$

where T_g=temperature of gas in °R; T_p=temperature of thermocouple junction in °R; h_s= surface coefficient of heat transfer in Btu/hr-ft²-°F; E=emissivity of thermocouple junction; T_w=average wall temperature to which thermocouple junction is exposed in °R.

Velocity Error

A thermocouple immersed in a gas stream will reach a temperature somewhere between static and total temperature. If a probe had the ability to stop the gas adiabatically and convert all kinetic energy to heat, it would measure total temperature (normally the required measurement in turbomachinery). A probe moving with the gas stream at its velocity would measure static temperature (Fig. 3).

The relationship between total and static temperature is:

$$T_t - T_s = V^2/2g\ Jc_p$$

where T_t=temperature of gas in °R; T_s=static temperature in °F; V=velocity of gas stream in ft/sec; g=gravitational constant 32.2 ft/sec²; J=mechanical equivalent of heat in ft-lb/btu; c_p=mean specific heat at constant pressure in Btu/lb°F.

The *recovery factor*, which describes efficiency with which the gas is brought to a halt, is:

$$r = (T_g - T_s)/(T_t - T_s)$$

where T_g is indicated temperature (°F). The recovery factor of a typical thermocouple varies between 0.65 and 0.90. Providing a small cup-type chamber around the junction improves recovery factor to approximately 0.99 (Fig. 4).

Time Constant

The formula for characteristic time for thermocouples taken from a Bureau of Standards report, is:

$$\tau_{G1}/\tau_{G2} = 1.03\ (G_2/G_1)^{0.5}$$

where τ_{G1}=characteristic time at flow rate G_1, in sec; τ_{G2}=characteristic time at flow rate G_2, in sec; G_1, G_2= rate in lb/sec-ft².

The characteristic time for a bare, 18-gage, chromel-alumel thermocouple is 1.2 sec at flow velocity of 250 ft/sec, or flow rate of 6.8 lb/sec ft².

The given formulas cannot be used to determine exact probe errors, but are useful in estimating errors which occur under varying conditions. They are also helpful in designing a probe with minimum error, and in permitting calculations of maximum error. A recent NACA publication, TN 3766, presents information on various designs of high-temperature probes commonly used in gas turbine testing. These are shown in Fig. 1.

Recommendations

Project engineers are continually demanding greater accuracy in measuring temperature throughout turbomachinery. A method of measuring gas temperature without an immersed probe, with its multitude of errors, would be extremely valuable, but remains unavailable. The temperature-measuring problem is urgent, and immediate effort should be turned toward development of more useful probes, such as new thermocouple elements which would be stable at high temperature, have high thermoelectric power, have minimal radiation errors, and provide automatic compensation for thermal lag.

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November Meeting: Thursday 21st at Rio Hondo Country Club.

Feature: Robert Lisk, Assistant Sales Manager of Fisher Governor Co. will discuss New Considerations in Gas Regulator Design.

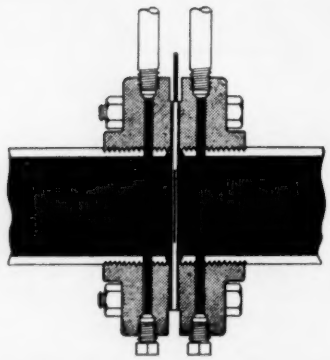


FIG. 1. ORIFICE FLANGE HAS TAPPED flanges (flange taps) for connections to either side of orifice plate.

RALPH C. CLEMONS, JR.
Daniel Orifice Fitting Co.

Orifice Fittings and Meter Tubes

Factory-fabricated orifice fittings and meter runs contribute to increased flexibility, serviceability and accuracy.

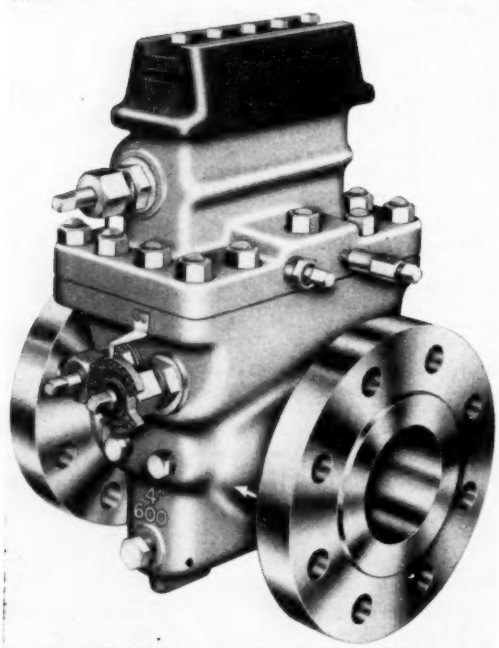


FIG. 2. "SENIOR-TYPE" ORIFICE FITTING permits removal of orifice plate without interruption of line flow and without use of bypass.

ACCURATE metering of natural and manufactured gases often requires inspection and replacement of orifice plates. The relative advantage of orifice flanges, fittings, and plate holders thus becomes an important subject.

The orifice *flange* union (Fig. 1) has been used as an orifice-plate holding device for many years. It gained prominence in the 1920's, particularly in the petroleum industry. It soon became apparent, however, that use of a flange union requires a bypass around the meter run so that the orifice plate could be changed or inspected as conditions warranted. Changing an orifice by this method was time consuming; it necessitated (1) handling three valves in the bypass manifold, (2) manually spreading the flanges retaining the orifice plate, and (3) removing the orifice for inspection. Operating personnel sought a device which would eliminate some of these difficulties associated with changing an orifice plate with a flange union. This is particularly important because research proved that abrasion, corrosion and "dishing" of the orifice plate cause errors of serious consequence, and many users inspect orifice plates monthly. Most users recommend inspection at least every ninety days.

Orifice *fittings* were developed originally for use in natural gasoline plants as a means for plate

Presented by J. R. Wilson, Daniel Orifice Fitting Co., Los Angeles, Calif., at the Los Angeles Harbor Junior College Instrument Short Course, Feb. 1, 1957.

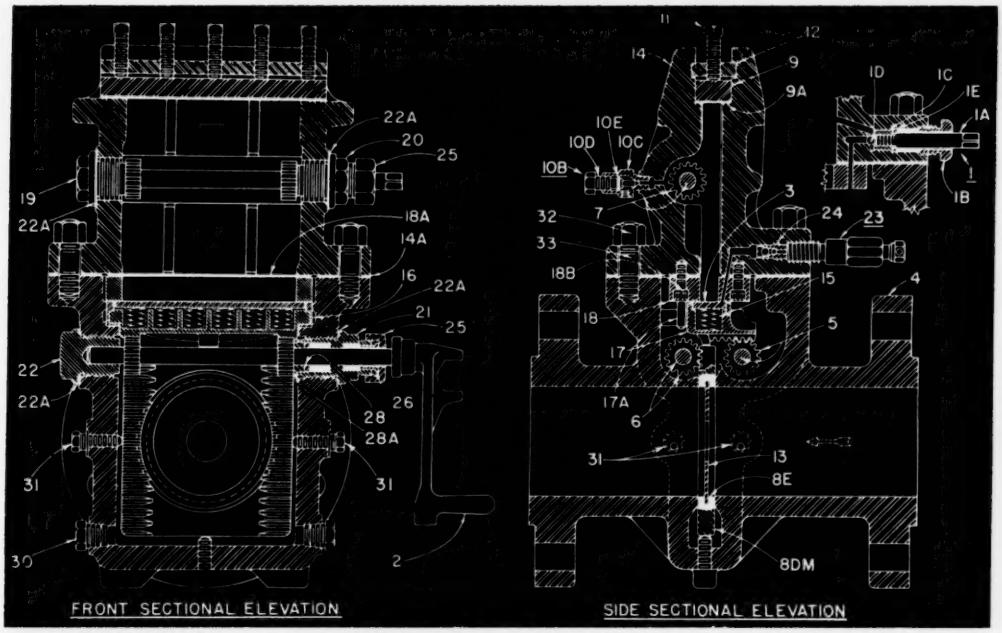


FIG. 3. CROSS-SECTION of "Senior" fitting. Slide valve (3) is first opened so that orifice plate and holder can be raised into chamber under T-bar (9). Then slide valve is closed and orifice plate removed.

changing without bypassing or shutting down flow. Fig. 2 shows a typical orifice fitting that permits the operator to bypass the orifice and change it without shutting off line flow.

A cross-section of the fitting shown in Fig. 2 is shown in Fig. 3. The orifice plate (with a synthetic rubber seal) fits into a rectangular *plate carrier* which is grooved on both sides to match a pinion gear. A slide valve (3) above this plate seals off the line from the chamber above the orifice. When it is desired to replace the orifice, this slide valve is opened by means of a gear (5), the orifice plate and carrier are then raised by a crank attached to the plate carrier pinion (6), and the slide valve is then closed. The orifice is now in a sealed chamber above the line, which can be opened safely and the orifice plate removed. Note that line flow was never interrupted in this "Senior-type" fitting.

Orifice fittings gained rapid acceptance because they enabled a man to perform in a few minutes a job that had previously required up to an hour. In larger lines the orifice fittings made possible even greater savings because several men had been necessary to handle the heavy pipe and flanges when orifice flanges were employed.

As the use of orifice fittings increased, and as accurate metering became more important, more versatile fittings were developed. Today, the American Gas Association, in its Gas Measurement Report No. 3, considers orifice fittings on the same basis as orifice flanges, recommending that the same tolerances of manufacture be applied to fittings as to flanges. This careful attention to manufacturing tolerances has undoubtedly accelerated the wide acceptance of orifice fittings by the gas industry.

Comparison of Flanges and Fittings

An economic comparison of a meter setting with an orifice fitting versus one with orifice flanges and bypass for plate changing shows that the fitting effects a first-cost savings in all cases except for smallest run sizes and lowest pressure ratings. In all larger runs (from 4″ to 30″) an orifice fitting is less expensive, regardless of pressure rating.

In pressures above 300 psi A.S.A. the first cost is lower in all sizes for a setting with a fitting. This is because of the cost of upstream and downstream block valves plus bypass valve, piping, and orifice flange. Increase in size merely increases the first-cost savings of orifice fittings.

Engineering comparison also reveals a substantial saving in operation time.

Finally, orifice fittings save space and are safer to operate than flanges. These advantages are paramount in gasoline plant and refinery installations where bleeding down a line to change a plate can be extremely hazardous.

Changing Orifice Plates With a Fitting

To remove an orifice plate from an orifice fitting, follow this procedure:

1. First open the equalizer valve, which permits the line pressure to equalize in the top chamber.

2. Open the slide valve by rotating the valve shaft clockwise until it stops.

3. Rotate the lower plate carrier shaft counterclockwise until the plate carrier has engaged the pinions of the upper shaft. Rotate the upper gear shaft counterclockwise until the plate carrier is all

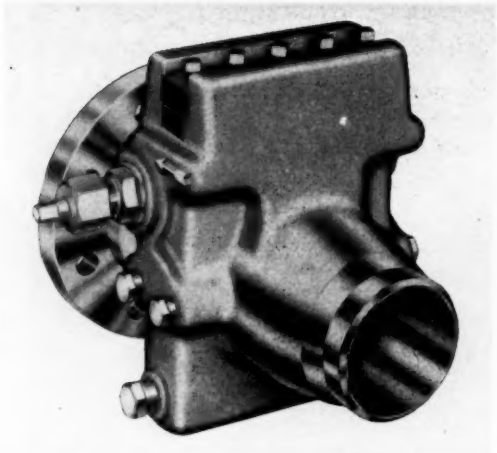


FIG. 4. "JUNIOR-TYPE" FITTING has crank for raising orifice plate holder out of line, but line flow must be interrupted.

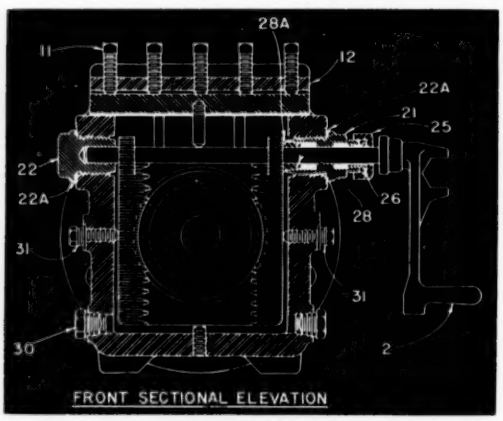


FIG. 5. CROSS-SECTION of Junior fitting.

the way in the top of the fitting and up against the bottom of the sealing bar.

4. Close the slide valve by rotating the valve shaft counterclockwise.

5. Close the equalizer valve.

6. Bleed off the pressure from the top chamber.

7. Loosen the set screws and remove the top clamping bar, then turn the upper plate carrier shaft counter clockwise to raise the plate carrier completely out of the top of the fitting. The orifice plate now can be removed from the plate sealing unit; no tools are required.

To replace the orifice plate in an orifice fitting it is necessary only to reverse the procedure described above, with one exception. It is necessary to equalize the line pressure into the top chamber before the slide valve is opened. Once the orifice plate is down into the center of the line it is well to close the equalizer, slide, and bleeder valves. Note—unless the plate is completely seated and centered, the slide valve will not close over the orifice plate carrier. This permits the operator to detect the presence of foreign elements in the seat of the fitting so they can be removed without delay or danger. The orifice fitting has a ¾" blow-off connection on either side at the very bottom. A nipple and gate valve should be installed in one connection so that the foreign element can be blown out.

An orifice can be changed in this manner in a few minutes, regardless of line size.

The "Senior" orifice fitting shown in Fig. 2 is available in 2" through 30" sizes in pressure ranges up to 2500 psi A. S. A., and in three basic body styles—flanged (maximum portability), weld neck (least expense), and "Flangnek" (finer points of both). The Flangnek style has a weld-neck inlet for accurate alignment of the shop-fabricated upstream section, and a flanged outlet for convenience of inspection.

Although the Senior-type orifice fitting was designed for accuracy of measurement of flow, it also has alternate uses. Common applications include low-pressure blanking-off and use as a gate valve.

Some time after the development of the Senior-type fitting, attention was given to the problem of changing plates where a bypass was in existence, or where several tubes were fed by a single upstream header, as is found often in city gas stations and many gas transmission meter settings. The time involved in changing conventional orifice flanges remained, even though bypassing was not difficult.

The "Junior-type" orifice fitting (Fig. 4) was thus designed to speed up and insure a safe method of plate inspection, particularly in high-pressure meter settings. This fitting is much like the Senior fitting but it does not have the top chamber for changing plates under pressure (Fig. 5). However, once the pressure is off, it is necessary only to remove the clamping and sealing bars and crank the orifice plate in its plate carrier out of the fitting.

On first-cost analysis, the Junior fitting costs approximately 20% more than a comparable high-pressure orifice flange union. However, the difference can be made up quickly in time saved; also, savings result from use of "Universal" orifice plates which cost about half the cost of conventional paddle plates used in orifice flanges.

Orifice Plate Holder

A third basic style or orifice fitting is the Simplex Orifice Plate Holder (Fig. 6), designed to be an economical and accurate replacement for orifice flanges where the frequency of plate changing does not justify a Senior-type unit. Like the Junior type, the Simplex requires that the pressure be removed from the line before the plate is removed for inspection. When pressure is off the line, the top set screws are loosened, and the clamping bar removed from the T-slot closure. Then the operator lifts out the sealing bar, plate carrier, and orifice plate as a unit. The concentricity of the orifice plate in the line is assured by a dowel pinning the sealing bar and plate holder casting.

There are three basic body styles in this unit. The "Flangnek" body design normally would be recom-

mended for services requiring frequent orifice plate inspection and most accurate alignment, such as city gate stations, gas transmission, gas distribution, and large industrial gas installations. The weld-neck body is normally supplied with factory tubes for such applications as gas storage or production. The Simplex with socket-welding ends is suitable where ease of operation is more important than extreme accuracy, such as in refinery or chemical and petrochemical applications. With socket-welding ends it is possible to use field meter tubes; the pipe is placed into the sockets and attached by back welding, thus minimizing the distortion caused by heat.

The Simplex style is of particular value for extreme pressure because spreading orifice flanges is an arduous task in high-pressure settings—the flanges are heavy, the pipe wall thick and, generally, the pipe runs are securely anchored to concrete blocks.

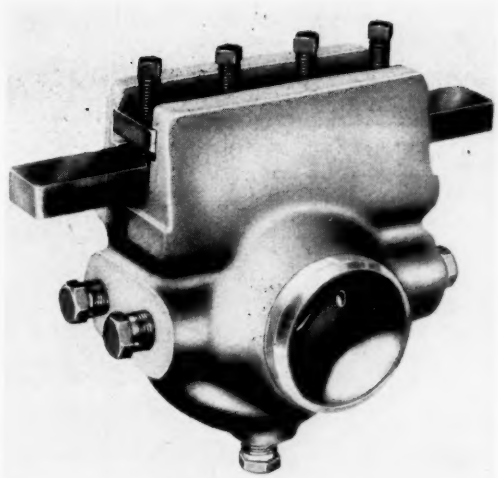


FIG. 6. "SIMPLEX" ORIFICE PLATE holder comprises flange taps, plate holder, and drain plug.

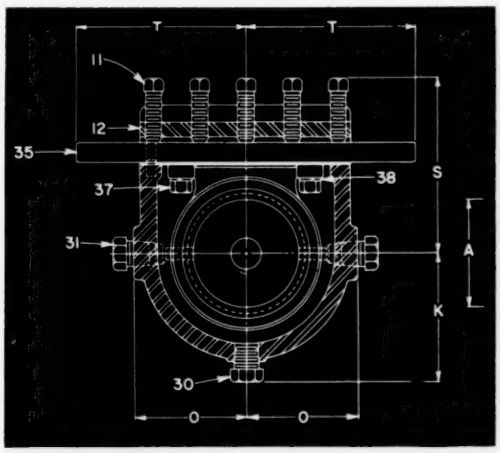


FIG. 7. CROSS-SECTION of Simplex orifice plate holder.

Orifice-Plate Sealing Units

The heart of any orifice fitting design is the orifice plate. Manufacturers use extreme care in producing the finished orifice because the orifice-meter accuracy depends on the differential pressure produced by the plate. The modern orifice plate is manufactured from stretcher-levelled stainless steel that is closely inspected. Uniform thickness is maintained by large table sanders which polish to recommended smoothness and flatness.

It is important that the orifice plate be positioned in the orifice fitting so that all of the gas flowing through the tube passes through the orifice and not around it. For this reason several successful types of orifice-plate sealing units have been developed to prevent bypass or leakage.

In the early 1940's the first non-metallic sealing unit was introduced and, although improvements have been made in modern materials, the basic unit design has remained unchanged. This unit is called the Dual Seal or DS (Fig. 8). Hycar synthetic rubber surrounds the outside of the orifice plate, providing rubber-to-metal seals on both sides of the orifice plate and on both sides of the orifice fitting body. This type of sealing unit is inexpensive and durable. For extreme pressures, or where rubber compound is subject to a small amount of swelling, a seal made of Teflon is recommended (Fig. 9).

Tap Location

The American Gas Association Gas Measurement Committee Report No. 3 has added specifications for more accurate location of flange taps or meter tap holes. This specification requires a more exact tap location in smaller pipe sizes; the tolerances apply to both orifice fittings and orifice flanges. (Orifice fittings are jig-drilled and the problem of tap location is minor.)

Conventional orifice flanges of past years are known to be less accurate in tap-hole location; when they are used extra care should be taken to locate the tap holes correctly. In the past it has been advisable to purchase orifice flanges rough bored and unfaced so that the bore could be made more accurately, and the facing carefully controlled to bring the tap holes within tolerance.

Meter Tubes

A great deal of study has been directed to the pipe immediately adjacent to the orifice fitting or orifice flanges. These lengths of pipe are known by several names, but are usually referred to as *meter tubes* or *meter runs*. Research has shown that the condition of this pipe affects measurement accuracy.

Manufacturers of orifice-metering equipment are gratified at the interest shown in the meter tubes by the gas industry. This is perhaps largely due to the value of the product being measured.

Proper selection of pipe for meter tubes is as important as properly boring the orifice plate. Pipe selected for meter tubes should be free from blisters, scale and striations, and should be smooth and

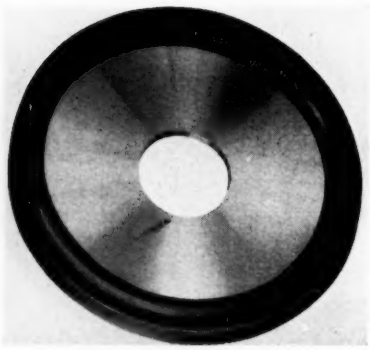


FIG. 8. DUAL SEAL (DS) orifice plate prevents leakage around plate.

FIG. 9. TEFLON clip-on seal.

cylindrical within the tolerances recommended by the American Gas Association Gas Measurement Committee Report No. 3. This report recommends that when the tubes are sized for orifice plates in d/D (beta) ratios of 0.65 to 0.75, the permissable out-of-roundness shall not exceed 0.5% with flange taps. For example, a 4″ tube shall be round within 0.020″, and a 3″ tube within 0.015″. The tolerances are even smaller when line or pipe taps are used. These tolerances apply to the upstream tube; the downstream section cannot exceed twice the upstream tolerance. The recommendations are for meter tubes using orifice fittings or orifice flanges.

It can be seen readily that an accurately bored fitting or flange must match a carefully selected tube, or a shoulder may result. Any shoulder at an orifice fitting or orifice flange would be close to the orifice and might set up turbulence.

It is impossible for field fabricators to economically fabricate meter tubes within recommended tolerances because alignment fixtures and special welding jigs are not a part of standard field-welding equipment. However, there have been numerous improvements in welding and machining procedure employed by meter-tube manufacturers in recent years. In the past, slip-on welding type flanges were the most popular, but as the trend has been toward increased accuracy and lower tolerances, the welding neck flange has grown in favor. This is partially due to the trend toward factory-fabricated tubes. Manufacturers consider the welding neck-flange superior to the slip-on flange whether used in meter tubes, at the outer ends, adjacent to orifice fittings of the flanged type, or as orifice flanges.

Honed Walls

In the past fifteen years much has been said about the honed meter tube. During and just after World War II suitable meter-tube pipe was not readily available in certain sizes, and the honed tube was developed in order to get meter tubes of sufficient accuracy for good measurement practice. The honed tube is a meter tube re-machined in a honing machine to the desired internal diameter and roughness. This practice requires the use of somewhat heavier-wall pipe so that after honing the resultant diameter is approximately the published inside diameter, within a range of ±0.004″. Although excellent meter-run tubing and pipe have been available for some years, the honed tube has grown in popularity and acceptance, particularly in the West. A consideration in favor of the honed tube is that the internal wall roughness can be controlled to a desired range by proper choice of honing stones.

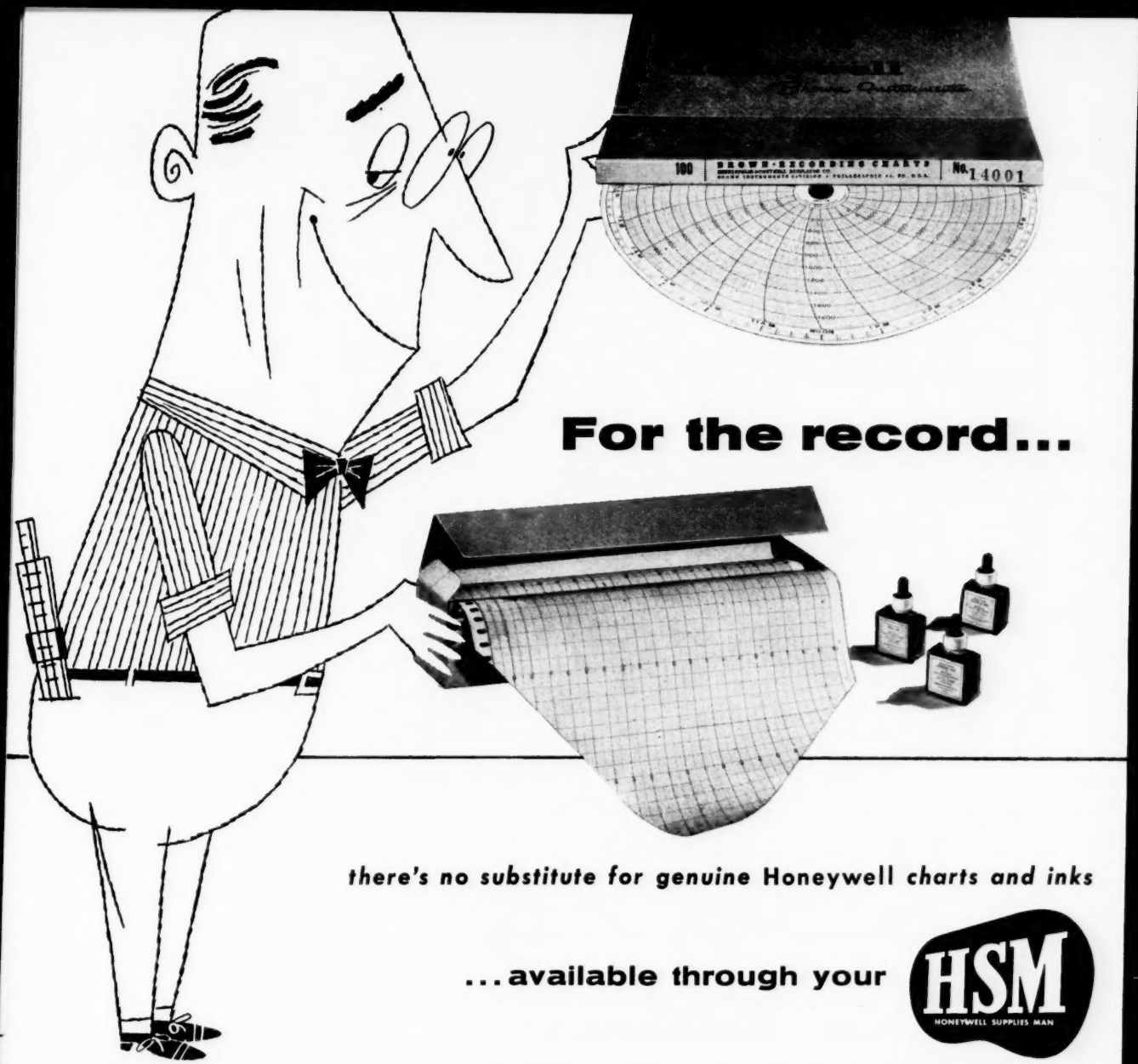
It is possible to hone meter tubes to a glassy-smooth surface, but this is not recommended practice because the flow coefficients now in use are based on standard mill-scale-roughness pipe, and it is believed that an excessively smooth tube tends to meter fast. Therefore, when honed tubes are used, the recommended roughness is that of new meter-run tubing or pipe. Tests are now under way at the U. S. Navy Boiler and Turbine Laboratory on the effect of varying roughness.

The primary advantage of the honed tube is uniformity. From a safety standpoint honing is satisfactory, because the hone will never weaken one wall of the tube and leave another thick. Honing does increase the cost of the meter tube.

Factory Assemblies

The increased use of factory-assembled tubes with orifice fittings has resulted in standardized meter-tube designs available from stock. Such meter tubes are sufficient in length for A. G. A. Case One and Two at a 0.75 beta ratio. With a straightening vane these tubes meet recommendations for any pipe disturbance. This is part of the trend toward the time when a flow-measurement problem may be answered by reference to a catalog number of a stock tube; the user will benefit by reduced delivery time and cost. Also, such standard tubes could save many hours of engineering, drafting, purchasing, and specification-writing time.

In general, orifice metering, insofar as the primary element and its adjacent pipe is concerned, has shown considerable improvement in recent years. Accuracy of orifice plates, orifice fittings, orifice flanges, and orifice meters is now coupled with similar accuracy in shop-fabricated and factory-controlled tubes. By recognition of the importance of the conditions surrounding the orifice plate, orifice measurement is taking its rightful place among other exacting methods of measurement.



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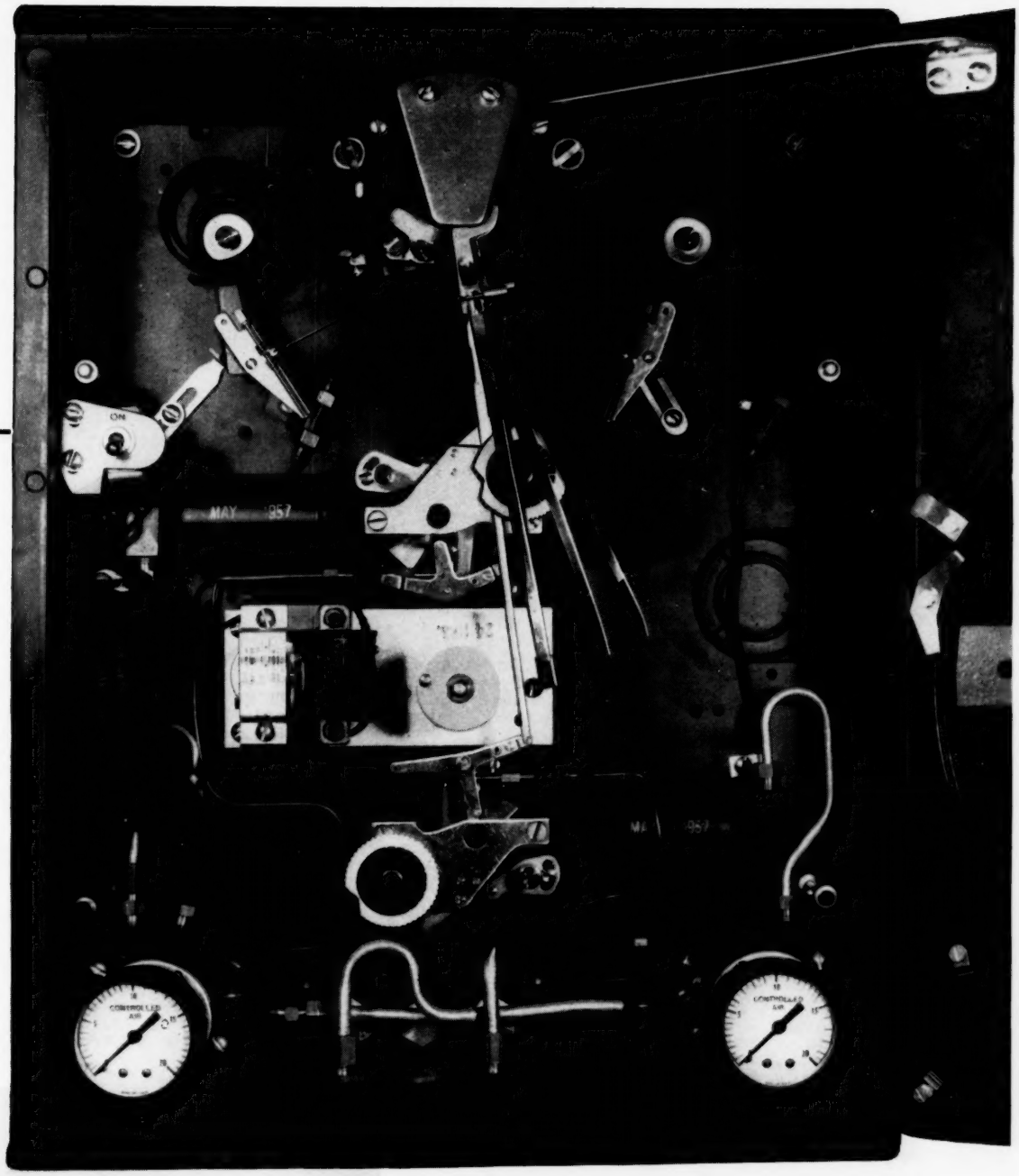

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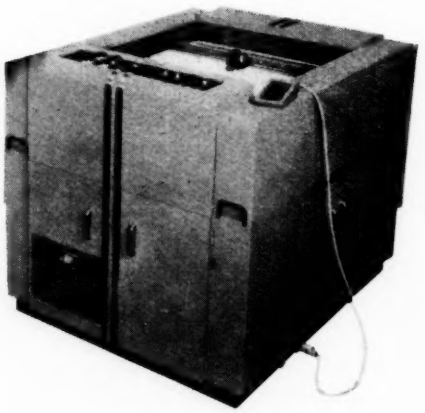

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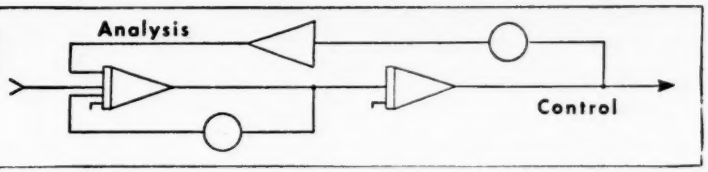

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Bits

This month, something a little different. No equations, no diagrams, nothing technical, but a discussion which should be of interest to management and managed: Multi-shift Operation.

This is debated under Pieces, and the debatableness (wow!) of the question is underscored by the fact that eminent (and I use the word advisedly) authorities do not exactly agree, to put it mildly.

If you are not concerned with the foregoing you might find some info under "Info" and you can check on the movements of a couple of people under "He Went Thataway."

Sorry (or am I?); no publishable Thot this month. Any contributions?

Pieces

JULY WESTERN S/C MEETING ON "MULTI-SHIFT COMPUTER OPERATION"

Jack Sherman (Lockheed Missile Systems Division, Palo Alto, Calif.) opened the July meeting of the Western Simulation Council. "We have," he said, "Two members on our panel with distinctly opposing views. If this discussion follows Simulation Council tradition we should hear some 'interesting' remarks!"

Forty-four representatives of 21 organizations had assembled at Douglas Aircraft Company in Santa Monica, Calif. on July 11th to hear and participate in a discussion of "Multi-shift Operation of a Computer Facility." As Jack predicted, this potentially dry subject elicited a lively discussion. The idea was that a panel composed of

Dov Abramis (Convair, Pamona, Calif.)
Bob Horwitz (Convair-Astronautics, San Diego, Calif.)
Irwin Pfeffer (Ramo-Wooldridge, Los Angeles, Calif.)
Don Totten (Naval Ordnance Laboratory, Corona, Calif.)

consider pros and cons of multi-shift operation to set off a general discussion of the subject from the floor. And there was some discussion from the floor, but the greatest interest centered about the diametrically opposed views of Irwin and Dov, each of whom made enough points to sway the audience one way and then the other.

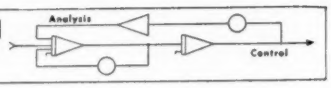
* * *

Jack asked *Bob Horwitz* to open the discussion. Bob replied that though he had only had experience with multishift operation, he thought the answer depended primarily on two major points: the amount of work, and the kind and amount of equipment to do it.*

"If you have a small installation—less than 100 amplifiers being small—it is likely that single-shift operation can be economically justified. If you have anything larger than that I have my doubts," Bob said. "Anyone want to fight?"

Irwin: "I don't have *that* strong a feeling on the subject."

* This could have been a summary instead of an introduction!



Jack: "What is your opinion, Don?"

"*Don*: "We have had an analog computer at NOL for about six years. During that time we worked one extended multi-shift operation: we operated a swing shift for about eight months. At other times we have worked short two-shift periods for three or four weeks. During the eight-month period we had trouble between the problems assigned during the day and evening shifts, and found it impossible to rotate projects from one shift to the next. The individuals on one shift might not use the same methods or techniques; or they might be involved with a different type of operation. Therefore we had to change problems between each shift and found that the time lost in setting up and checking out amounted to something like two hours per shift, or about four hours a day. This was on problems using 200 or more amplifiers.

"Now there were some difficulties. We had trouble finding people who were willing to work the night shift for the salaries we could pay. Then too, people working that shift weren't able to attend the daily meetings and activities of the department. Communication and personal development suffered. The men seemed to grow stale. I suppose this could be offset by rotating the shift. The equipment however, didn't show additional wear because of the extra use. We did notice, though, that because our equipment was only down when it had to be down, our troubles added up. This resulted in a lot of down time, trouble shooting and such during the regular shift.

"We also found that people working on the swing shift were probably not working as efficiently as if they had been working during the day. For some reason they were just not able to produce as effectively at night. I don't know whether this was caused by lack of close supervision, or what. In short, we found that if a group cannot possibly get the computer time they must have during the regular shift, an extra shift probably will increase the computing time by a factor of something like one-half.

"We think we have found a better solution. This is one that *Jack Sherman* used at the Naval Air Missile Test Center and might be referred to as an overlapping extended-shift operation. In our case we had a two-week cycle. We had two shifts working 10-hour days, and four-day weeks. The days were arranged so that a problem could stay on the equipment for as long as eight days if necessary.

"We also found we could improve efficiency ahead of time by examining our problems carefully before we ever went near the computer, by going out of our way to cut down on operational trouble, and by trying to do necessary maintenance after hours. In this way we believe we were able to accomplish as much work during one shift of computer operation as we could formerly with two shifts."

Irwin: "I think the appeal of this system is the five-day weekend every other week. We all talk about four-day weeks and here is an approach."

Willard Uplinger (USNAMTC, Pt. Mugu, Calif.): "I would like to testify on that matter of the five-day weekend. For some time we were doing extensive remodeling at Mugu and had to shut down computer operations entirely. It seemed best to put everyone back on the regular five-day week, and after that I doubt whether one day went by that someone didn't come to me and ask 'When are we going back on the shift?' It was extremely popular."

Wayne Abern (USNAMTC): We get so much time off we have trouble using our leave!"

Abramis on Three-Shift Operation

Don: "The two people with opposing views that Jack mentioned are undoubtedly Irwin and me. I'm a great believer in the three-shift operation. I've worked with it for years. We started as a single shift but went to three shifts by necessity. If we didn't have them we would not be able to accomplish even a major fraction of the total work we now put out.

"All of you undoubtedly have been reading in the papers that the Air Force gathered all the contractors together recently and read the riot act. As I understand it, they were saying that we have got to get the mostest out of what we now have. So I venture to say that within a few years any computer installation that is still on an eight-hour day, one-shift operation, is going to have a tough time competing with installations that operate more efficiently by simply being on the equipment more of the time.

"Let me give you a brief description of how we operate. The analog computer is on the air seven days a week including holidays; five days on a three-shift basis, and Saturdays and Sundays on one shift. As with everybody else our overtime problem is a whopper, so we have to establish shifts. We have some people working Tuesday through Saturdays and some people working Sunday through Thursday. We haven't tried this overlap system because there are already three shifts.* We use Saturday and Sunday mainly for maintenance and modifications, the kind of maintenance that requires stopping the computer. Maintenance of other sorts is going on all the time.

"Most of the computers operate on an open-shop basis. This means that a man from another group—in our case usually Dynamics—comes in and uses the computer at the same time that our staff is there. So Dynamics established a rotation system three or four years ago in which every operator is required to take four weeks of the first shift and four weeks of the second shift. They got in the habit and it has been going on without too much trouble. However, this means that every four weeks, when you shift operators, you shut the problem down and also have to shift consoles. There is no doubt that in doing this we lose a certain amount of setup time. The question is, would we have gained more by staying on one shift?

"The third shift at the moment is operated mostly by people on our staff. We have people who go to school during the day and come to work on the third shift. Other people like the third shift because they want to help their wives and putter around the yard. Such people are not easy to find, but it can be done.

"We put problems on the third shift which have lower priority, but at least we get them done. We don't have to tell the customer 'Sorry, come back in six months from now because the computer will be busy until then on high-priority work.'

"When the third, or second, shift is idle—and we do have idle days—we get our maintenance work done. We perform test work and modify the equipment. In this way we have been able to keep the equipment,

* It won't work for three shifts.—Ed.

some of which is '49 or '50 vintage, up to date in 1957. We probably wouldn't have been able to do this if we have not had the three-shift arrangement.

"When prepatch came along, the main excuse for one-shift operation disappeared. Large problems can now be reset without losing a major portion of a shift. There is no doubt that a complex problem will take two or sometimes three hours to set up. But what is the alternative? You will have to stack work up in series on the first shift rather than get it done in parallel by multi-shift operation. When the setup time gets to be a major fraction of a full shift we run two shifts in succession with two different groups of personnel. The problem is set up on the second shift; there is an overlap time with people coming in on the third shift who later make the necessary runs. It works very effectively. In certain cases when we had tolerance studies which required a great many repetitive runs we have run problems around the clock with three groups. Experts on the problem worked during the day when things were set up and checked out, then more or less routine runs were made by the other two shifts.

"To sum up my case for multi-shift operation. I don't think we have much of a choice. We are dealing with instruments which, in our case, are in the million-dollar category. These instruments *can* be used around the clock. It won't harm them; it might even do them good. Shutting them off would be more harmful. It is much more economical, in terms of what you get for the dollar, to operate a giant installation around the clock even if the second and third shift may not be as efficient. It seems to me that as installations get gianter and gianter it will be impossible to maintain a competitive position without a third shift."

Pfeffer on Single-Shift Operation

Irwin: "I would like to take issue with about everything that has been said! I feel that in general multi-shift operation is not efficient.

"Most of my arguments will be based on reason and logic; I have not operated a computer on a night shift and I hope I never have to.

"There are three important points I would like to make. One is that I doubt seriously whether there is any return for working at night—for most operations. By your own admission, Dov, you said a little while ago that as an average the change-over of problem takes two or three hours. Let us assume that we are going to work different problems on each shift. Figuring two-and-a-half hours changeover time on each shift, out of 16 hours you lose five, leaving 11 hours running time, whereas you would get eight with only one shift if the problem were left on the machine all the time. If we assume you are working two complete shifts, both of them fully manned, you are paying 200% the personnel costs of one-shift operation and you are getting about three hours, or 37½%, extra running time.

"Besides, I think it is very obvious, as Dov said, that the second shift tends to be less efficient than the first. As a matter of fact it has been estimated to be about 70% as efficient. Now let's consider this on an economic basis. Suppose the computer costs $500,000. About 12 people would normally be involved in operating such a computer on a one-shift basis. When you figure out loaded costs, the cost per person to a company comes out to be about $20,000 per year. If you have 200% personnel on two shifts and are only getting 137½% of efficiency, then you are paying something like seven or eight people for no output.

This means that you are paying about $140,000 for wasted manpower. And this is still assuming that the efficiency of the second shift is 100%! $140,000 per year would enable you to write off the cost of a new computer in less than four years, so I claim that if you have the work load you should purchase a second computer and operate them both with full one-shift efficiency. Of course this is an economic argument which can be argued back and forth—and probably will be!

"Another point: I think it is very difficult to get good people to work at night. I have inquired around a good bit, and invariably the answer is No unless they can get a very high premium. Now I am talking primarily about a closed-shop operation, which means that if you work at night one-half of the personnel work at night all the time or all the people work at night one-half the time. With open-shop operation the situation might not be so bad because you might be able to bring in different customers so that a person might have to work at night only a small fraction of the time if a sufficient number of people were using the machines. However, according to a survey I made, more than one-half of the analog-computer installations are closed shop.

"Finally, even if you can get a few people to work at night, it is very difficult for these people to maintain direct contact with the kinds of problems they are working on. In order to work efficiently on most types of analog problems it is absolutely essential that the people working on the computer understand the problem in great detail. They must know the range of each variable, and what the important results are likely to be. It is going to be difficult for the computer people who work at night to keep in touch with others in the organization who are intimately conversant with the problem and can impart essential information, because this latter group will normally be working the day shift.

"So I submit the following as three major disadvantages of multi-shift operation:

1. I don't think you can get good people to work at night.
2. It is very difficult to make contact with people concerned with your problem when you are working at night.
3. The efficiency of multi-shift operation is very, very low.

"It has been pointed out that production-type problems can be done at night. A problem is left on the computer and two shifts work on it. The day shift does the thinking and the night shift does the production. This may work out, and in some cases does. Many problems, however, do not have a production phase. It has been my experience that some of the most useful and creative work to come out of analog computers is of the design type, in which one or two, or half a dozen, curves on a piece of paper tell a significant story. I seriously question whether a great deal of the creative or important work comes out in the form of reams and reams of paper. A good man working with a computer and using his head can get results in a short time and without reams of paper. More than we realize, the important contributions of analog computers have been of this kind.

"I invite criticism."

Bob: "Actually all these arguments only point out the futility of

trying to run a closed shop! Besides, what do you do when you have more work than your equipment will handle?"

Irwin: "We try to get more equipment. We feel that this is more efficient from the money point of view than trying to pay people to work inefficiently at night."

Dov: "Have you been able to convince the Air Force of that?"

Irwin: "Actually right now things are rather bad because of the tight fiscal situation. However, I think chances are that we will get additional equipment to accommodate our additional work-load."

Bob: "What about maintenance costs? They considerably overshadow personnel costs."

Norm Irvine (Convair, Pomona, Calif.): "Are you implying, Irwin, that there is no good substitute for a good engineer when you say that a good simulation man can spot important phenomena from one or two curves?"

Irwin: "A good engineer armed with a computer can accomplish a great deal more than five or six engineers who don't know what they're about: for example, students working at night who haven't got their degrees and don't have the know-how or experience."

Norm: "In this case the real argument for your particular stand for one-shift operation, and for Bob and Dov's for multi-shift, is basically the type of problem. You are talking about something that is really pushing the state of the art. in which case you need sharp people to recognize the significance of a particular blurp on a piece of paper. You apparently do not have many things like tolerance studies which, on an analog computer, are probably best handled by having some flunky sit and push buttons. Five or six parameters can make a pretty good matrix; you might have to make 100 repetitious runs or more. This doesn't require a guy with a lot of stuff in the upper story. I think this multi-shift operation pays off like mad for those who have such work. You can have your real sharp boys on the day shift to set up the program."

Bob: Even in Irwin's case it would be of value. Unfortunately Ramo-Wooldridge isn't in San Diego where there are fine engineers who are also skin-divers and who love to be off during the day so they can go diving and who work on the second or third shift."

Jack: "We apparently do have differences of opinion."

Ladis D. Kovach (Douglas Aircraft Co., El Segundo, Calif.): "We have a closed shop; our problems vary—we don't have any one type. Sometimes we run out of engineers. Sometimes we run out of equipment. We can't get more equipment. It takes a couple of years to get an appropriation. We can't get more engineers—we have to wait till commencement time. So what do you do when you run out of either engineers or equipment? The obvious solution is to go to multi-shift operation in the following manner, which we have done.

"Most of us are fortunate enough to live in an area where there are computer services available. Take your problem to someone else and let *him* worry about it. He's got the equipment. He's got the engineers. He can set the problem up, and you can forget about it!"

C. E. Lund (Douglas Aircraft Co.): "As you know, we have only had our computer about two months. We thought of multi-shift operations as the most feasible way out. Whether we follow Dov's example —put one problem on for eight hours, take it off and then put on another—or as Irwin suggests—running one problem day and night —I feel will be decided by the problem. If all your function generators, etc., are used in the problem it is definitely not advisable to keep shifting. But if you have a linear problem and have only one-half to one hour setup time, it would probably be more efficient to change each shift.

(Speaking to Dov)—"If you have different problems on each shift and if, as at Douglas, you have a closed shop, do you assign an analyst to operate the computer and also ask an engineer to come in and see whether or not the solution is correct? Oh should I just let the analyst sit there and run problems all night, hoping that the problem was correct as first set up?"

Dov: "In some cases, we have done exactly what you said. We have invited the engineer to come in on the third shift—from 12 to 7 in the morning—to see how the runs are being made. He doesn't have to be there every day for three months, but if he is really interested in the problem and wants to get results, if there is pressure on him to write a report which will recommend or not recommend certain action, it is not too much to ask him to come down a couple of days on the third shift. I hope we get a chance to have a rebuttal."

Jack: "One way to increase your capacity for computing, perhaps the quickest, easiest, and cheapest, is overtime. If you work your computer people on the machine 10 hours a day, six days a week, you get a 50% increase in computer use for 30% increase in salary*."

Bob: "You'd run up against Charlie Wilson, too!"

Jack: "Government restrictions aside, this is actually the quickest way to get expanded capacity. All you are paying for is the actual increase in salaries; you are not paying for the total increase in man hours. The salaries are a small part of the total operating cost."

Irwin: "With the two-shift overlap arrangement Don described, none of my objections to multi-shift operation hold. First, I think you can get good people who are willing to work four 10-hour days because of the long weekend every second week. Second, it is possible to maintain intimate contact with the people who are working with the computer group. Third, the time required to change the problems is decreased as

*HOW'S THAT AGAIN DEP'T: Wouldn't straight time cost 50% more in salaries and time-and-a-half 75%? How do you operate, Jack?

a problem may be left on the computer for as much as eight days at a time. If our work continues heavy and we cannot get the extra equipment (which we feel is the best solution) we will probably go to such an arrangement."

Norm: "Jack said overtime was the best way to get extended machine time at low cost. This works out fine on a crash deal—three weeks or less. But I have found that for longer periods the efficiency falls apart."

J. Seigel (North American Aviation, Los Angeles International Airport): "How much of the two to three hours setup time that was mentioned goes to setting up arbitrary funtion generators?"

Irwin: "You can set up perhaps four an hour."

Seigel: "What is true now might not be true six months or a year from now. I'm not a vendor, but there is the Stephen-Douglas* function generator that can be set up in a matter of five seconds. I believe that such things will make multi-shift much more feasible."

Bob: "Products like this are coming out because of the demand for multi-shift operation."

Bill Kindle (Electronic Associates Computation Center, El Segundo): "A primary concern at our computing center is to show off our computers—at their very best—to potential customers, so we are concerned with efficiency. This concern is increased by consideration of the hourly rental for our equipment, so there is tremendous pressure for efficiency. I believe that we get at least twice the efficiency from machines now operating in the computation center that we got from multiple-shift operation when I was at Cornell. I think the principal reason is the emphasis on getting problems well coded, on using techniques which speed the solution, and on a lot more preparation before getting to the machine."

Dov: "I think one of the best arguments against Don's lap-shift arrangement is the inefficiency of a 10-hour day. Our higher-ups are convinced that continuous overtime is bad because people come to expect it as part of their regular pay check. Aren't the last two hours of the 10-hour day spent in goofing off?"

R. K. Seferian (Rocketdyne, Reseda, Calif.): "How about buying time?"

Bob: "This is not always practical, particularly when you have hardware to tie in."

*1650 21st St., Santa Monica, Calif.

Uplinger: "At Mugu five years ago we were trying to work on a regular three-shift basis. Sometimes we found one of the two shifts was taken up entirely with tying hardware into a problem. That, I think, was one of the big reasons that we worked out the shift operation that Don described and that we continue to use at Mugu to this day." (See details under Info—Ed.)

Wayne Hoover (Reeves Instrument Corp., Santa Monica): "We have published a little book called *Efficient Utilization of Analog Computers*. You are welcome to a copy."

John McLeod: "Jack, I would like to make two remarks about that split-shift operation, one pro and one con. There are four or five people in this room who had something to do with working it out. In favor is the fact that because we had to get permission from Washington to work that kind of shift, the management engineer's office assigned a man to come over and get all the facts and figures. He found that based on useful hours of the computer operation, we showed about an 80% increase or 180% of our former efficiency. As a result, the Commanding Officer sent a recommendation for an Efficiency Award to Washington which would have amounted to $150 each for everyone in the group of six people who had anything to do with the plan. However, somebody in Washington evidently didn't like computers or computer operators because the recommendation got slapped down. The thing against it was that though it worked out very well for two-shift operation, we could not figure any way to stretch it to three shifts. You just can't make three shifts dovetail the way you can two."

Don: "Jack, another point. Quite a few people think of analog computers as a combination of unreliable humbug. There are a number of others who think of them as genuine computers. Certainly in the past we have had difficulties, but I think the designers nowadays are tending toward more reliable equipment, more automatic methods of setup, operation, and checkoff. Possibly in years to come some of the problems we are discussing here will no longer exist."

Jack: "I think what you are saying is that analog computing isn't a science—it's an art."

Don: "At present."

Mike Foley (Foley and Company, North Hollywood): "I can elaborate on that last remark. I have read quite a few papers by original developers and vendors of what they called automatic computers at the time. I'm sure they would be distressed to know what labor-thirsty beasts these automatic machines have turned out to be. You won't really have automatic computers until you get more automation."

Jack: "That's because the people who design the computers are engineers and not computing people. I know of no manufacturer who has computing people responsible for the primary computer design. Sorry to say this, but it's true."

Mike: "More automatic computers would relieve the manpower situation rather than create the need for more engineers."

Irwin: "All good inventions create more need for manpower. Let's hope the computer was a good invention!"

Bob: "A computer is only as good as the guy who is turning the knob."

Information (Without Theory)

The following is the most inspiring letter in this month's mail. While ye Ed. and others bemoan the shortage—no longer of engineers and scientists, but of really *good* ones—here is an organization which is doing something about it! Their effort certainly deserves any help any of us can give them. The letter:

"We have a USISCO JUNIOR SCIENCE CLUB, whose membership consists of youngsters from 6 to 16 throughout the country. In order to promote education and foster interest in science, we intend to send to our members regular circulars and material containing information of interest to young budding scientists; information such as, new adventures in science, dates and places of special science events, college scholarships, etc. It would be greatly appreciated if you

could supply us with any material or information you have available along these lines, or advise us where we can obtain such information for free distribution to our members . . . .

Very truly yours,
William B. Cherevas
U. S. Industrial Scientific Co., Inc.
744 Harrison Street
San Francisco 7, Calif.

* * *

A news release on Mid-Century throws further light on our comments of last month. "New Capital, New Board, New President—Mid-Century Instrumatic Girds for Expansion" states that

"Mr. *Robert K. Stern* has been appointed President of the Company. The new Board of Directors includes *John Wallace* and *David S. Gottesman*, Hallgarten & Co.; *Winfred Berg, President*, PIC Design Corp., subsidiary of Benrus Watch Co.; *Dante E. Broggi*, President, Neptune Meter Co.; *Abraham Rosenberg*, Vice President, Federal Machine and Tool Co., Inc.; *Thaddeus J. Kusto*, Mid-Century Instrumatic Corp.; and Mr. Stern . . . . In discussing plans for the future, Mr. Stern stated: "Mid-Century Instrumatic Corp's. research and development program will be directed towards producing and marketing equipment which adds programming techniques previously used only in digital machines."

In discussing his plans Mr. Stern is quoted as saying in part: "We hope, in fact, to put the analog computer in the running with digital machines for top sale honors in the industrial market."

(*I B M please note. Gratuities in appreciation of this tip should be addressed to 8484 La Jolla Shores Drive, La Jolla, Calif.—Ed.)

The shift arrangement *Don Totten* mentioned in "Pieces" is a variation on the original worked out by *Don, Jack Sherman, Don Teague, Willard Uplinger, Wayne Abern, Ken Grover*, your Ed. and others in the Simulation Laboratory at the Naval Air Missile Test Center, Point Mugu, years ago. It is based on two ten-hour day, four-day week shifts staggered as follows:

S	M	T	W	Th	F	Sat	S	M	T	W	Th	F	Sat
	A	A	A	A						A	A	A	A
			B	B	B	B		B	B	B	B		

Advantages are:

1. Problems must be changed only once a week.
2. Everyone works a day shift.
3. Communication with the "customer" is adequate.
4. The overlap days allow flexibility; e. g., if shift which has been on computer is "in business" they can arrange to stay on while the other shift is doing desk work; or, if they have to do some "head scratching" the other shift can get on a day early.
5. The five-day weekend attracts and keeps talent.

He Went Thataway!

Bill Bradley to Scientific-Atlanta, Inc., 2162 Piedmont Road, N. E., Atlanta, Georgia, where he is now Sales Manager. He demonstrated a good high-speed digital printer to us too. More about this next month.

Granino A. Korn (of the team of Korn and Korn, authors of *Electronic Analog Computers*) has been appointed to the faculty of University of Arizona at Tucson as Professor of Electrical Engineering.

Computer Events

Third IRE Instrumentation Conference

Dates: 11-13 November 1957

Place: Atlanta Biltmore Hotel

Included are sessions on Data-Handling Systems, Analog-Digital Conversion, Data Reduction and Processing, Recording Devices and Techniques, Instrumentation Methods and Principles

For information (and your Confederate 5-dollar bill) write B. J. Dasher, Georgia Institute of Technology, Atlanta, Georgia.

Southeastern Simulation Council

A meeting will be held in conjunction with the Third IRE Instrumentation Conference listed above. For information (and another $5) write Bill Bradley, Scientific-Atlanta, Inc., 2162 Piedmont Road, N. E., Atlanta, Georgia.

MAECON—Mid-America Electronics Convention

Dates: 13-14 November 1957

Place: Municipal Auditorium, Kansas City, Missouri

Under the sponsorship of the IRE, Kansas City Section. Represented on the General Committee are Midwest Research Institute, Vendo Corp., Bendix Aviation Corp., Great Lakes Pipeline Col., Wilcox Electric Co.

Sessions will be held on Simulation, Medical Electronics, Engineering Management, Airborne Electronics, Microwaves, Automation, Electronics and Nucleonics. For information write MAECON, 5109 Cherry St., Kansas City 10, Mo.

Symposium on Analog and Digital Computation and System Dynamics

Dates: 19-20 November 1957

Place: Wright Air Development Center, Wright-Patterson Air Force Base, Ohio

There will be one combined session on topics of interest to all groups, followed by separate meetings on digital computation, analog computation, and system dynamics. For information write A. C. Robinson, Aeronautical Research Laboratory, WCRRY, Wright Air Development Center.

Simulation Councils, Inc. (annual meeting)

Dates: 9-13 December 1957

Place: Washington, D. C.

This meeting will be held in conjunction with the Eastern Joint Computer Conference.

For Information on the meeting write Dr. R. M. Howe, Department of Aeronautical Engineering, University of Michigan, Ann Arbor, Mich.

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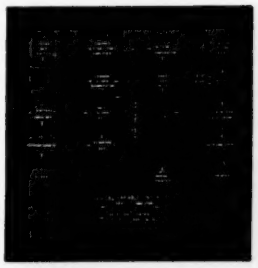

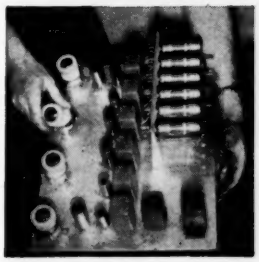

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INSTRUMENTS and AUTOMATION

New Instruments

CONTENTS OF THIS DEPARTMENT

Acceleration	1927	Flow-rate	1918	Process Measurement and Control	1916
Actuators	1964	Force	1927	Rectifiers	1955
Computing	1929	Inspection	1942	Relays	1958
Counting	1934	Laboratory Equipment	1936	Resistors	1957
Data Processing	1929	Liquid Level	1918	Shop Equipment and Supplies	1939
Dimensional Gaging	1942	Mechanical Components	1962	Speed	1934
Electrical Components	1956	Mechanical Testing	1944	Switches	1958
Electrical Instrument Accessories	1953	Miscellaneous	1967	Temperature	1920
Electrical Instruments	1950	Motors	1960	Time	1934
Electrical Testing	1946	Nucleonics	1966	Vacuum	1923
Electromechanical Components	1958	Photography	1966	Valves	1962
Electronic Components	1957	Positioners	1964	Weight	1927
Electronic Instruments	1950	Power Supplies	1954		
		Pressure	1923		

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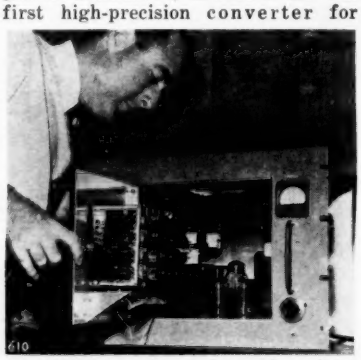
PROCESS MEASUREMENT and CONTROL

AN-DIG CONVERTER FOR PROCESS CONTROL

New ADIT (Analog Digital Integrated Translator) is said to be "the first high-precision converter for

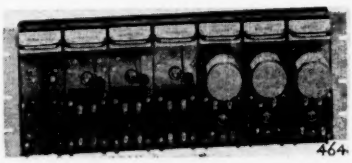


translating analog information characteristic of temperature, pressure, flow rate, etc., into digital information for data processing." Since it is all-electronic, it uses no active electrical contacts whose wearing out causes breakdowns in conventional electromechanical converters.—*Weston Electrical Instrument Corp., 617 Frelinghuysen Ave., Newark 5, N. J.*

For more information circle **201** on inquiry card.

TRANSISTOR TONE TELEMETER

New TT1 tubeless 18-channel system improves system reliability for remote metering and control at a greatly reduced unit price. Sharply notched bandpass filtering permits allocation of tone channels 120 cycles apart. Tone signals can be applied simultaneously as a composite signal to any private open wire, cable radio

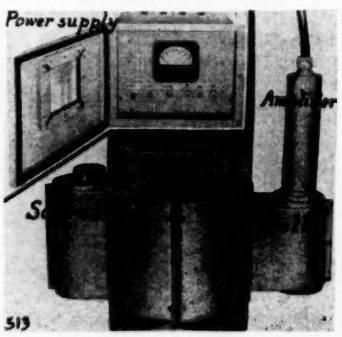


or microwave system, hence multiplying telemetering circuits.—*The Warren Mfg. Co., Inc., 10 Lake Ave., Littleton, Mass.*

For more information circle **202** on inquiry card.

RADIOACTIVITY-TYPE DENSITY GAGE

New Model LSG measures or controls process variables by measuring the density, specific gravity, or per-



cent solids of the process material; meets need for a lower-priced instrument suitable for applications requiring a high degree of precision but not necessarily the extreme sensitivity offered by maker's Model SG. —*The Ohmart Corp., Dept. 223, Bogen St., Cincinnati 14, Ohio.*

For more information circle **203** on inquiry card.

CONDUCTIVITY RECORDER

New battery-operated electrolytic conductivity recorder, for locations where electrical power is not available, has circular chart driven by a spring-powered clockwork. Choice of chart speeds. Electronic portions completely transistorized to minimize battery drain. Unit is direct-reading in micromhos and can be supplied with various ranges for electrolytes from distilled water to strong acids. Automatic or manual temperature compensation can be supplied.—*Industrial Instruments, Inc., 89 Commerce Road, Cedar Grove, Essex Co., N. J.*

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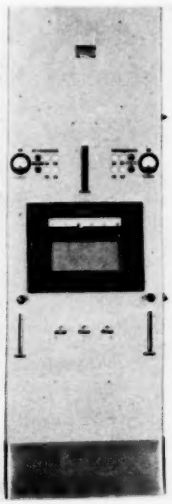
PROCESS-STREAM ANALYZER



New Electro-Conductivity Analyzer, for continuous monitoring of parts per million content in air of any gas or vapor which will ionize in water (or whose combustion product will ionize in water), can be employed either for toxic gas control in work areas, or for tracing impurity analysis in process control. Available for indicating, recording or controlling. Illustration shows system for simultaneously monitoring 50 ppm in air of freon and trichloroethylene.—*Davis Emergency Equipment Co., 47 Halleck St., Newark 4, N. J.*

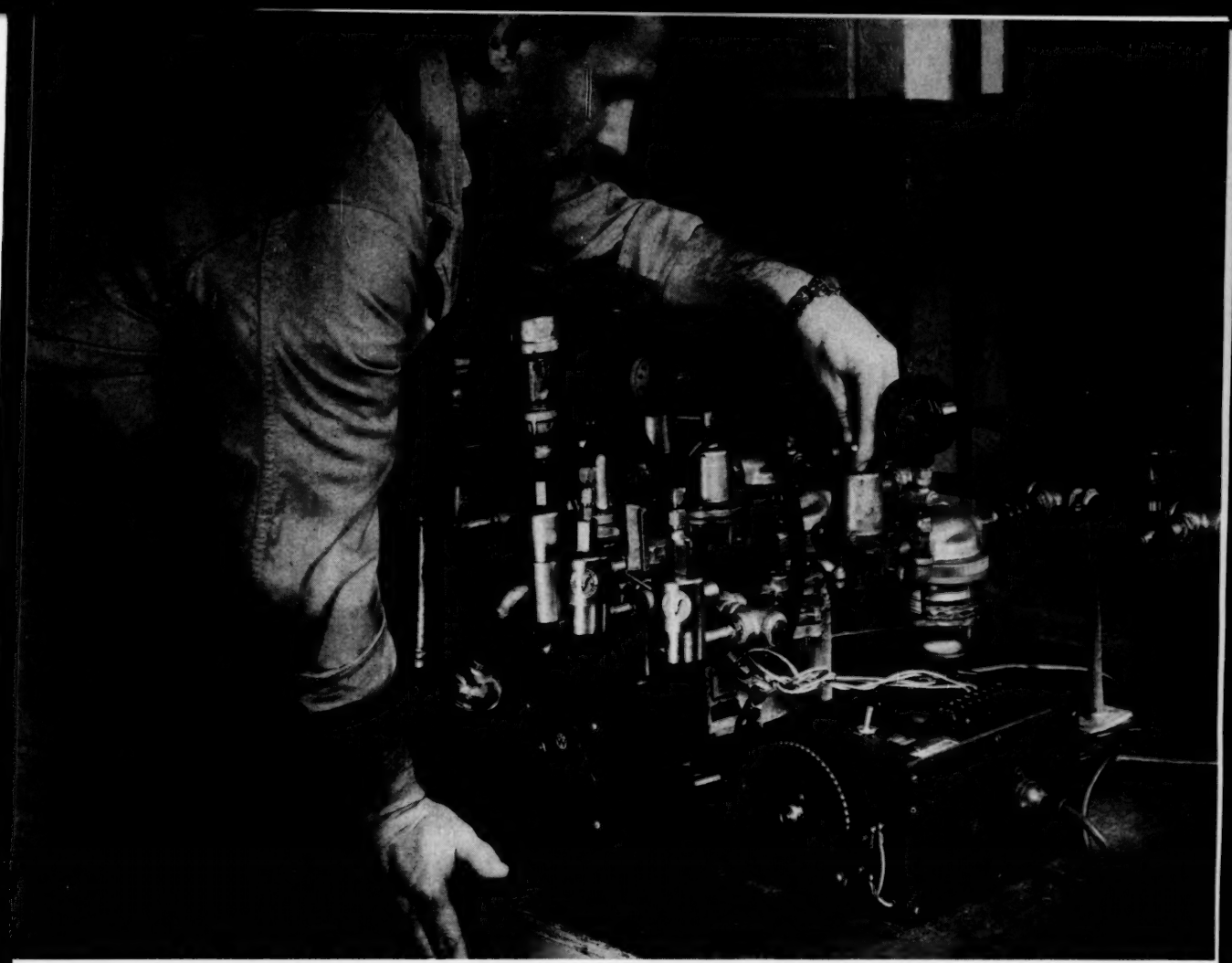
For more information circle **205** on inquiry card.

DENSITY AND GRAVITY CONTROL SYSTEM

New JSP-173A can measure and control density and gravity of any process material passing through a pipe vertically or horizontally. Since no part of this system comes in contact with process materials, it cannot be affected by corrosive material. Originally developed in cooperation with the AEC, prototypes have been functioning successfully on government projects for several years. Recording and controlling devices can be located up to 2000 ft away.—*Instruments, Inc., Tulsa, Okla.*

For more information circle **206** on inquiry card.

Circle **56** on inquiry card. ⟶



You can expect extremely long life from Skinner Solenoid Valves. Here's why...

In the lab shown above, dozens of Skinner valves are life-cycled 24 hours a day, 7 days a week, at speeds as high as 600 cycles per minute. It is here that we try out new designs, new materials, new construction methods. It is here that we test the stability of our welded joints . . . the resistance to burnout of our coils . . . the effectiveness of our positive spring returns . . the better seal we obtain by eliminating packings. And it is here we find positive proof of Skinner valves getting over 20,000,000 cycles without leakage.

Service records of many millions of trouble-free cycles indicate that these constant laboratory tests are worthwhile and necessary to assure outstanding performance on critical applications.

For complete information on Skinner's line of 2-, 3- and 4-way valves, write us or contact a Skinner representative. Write Dept. 410.

Skinner Solenoid Valves are distributed nationally

SKINNER ELECTRIC VALVE DIVISION
NEW BRITAIN
CONNECTICUT

NEW INSTRUMENTS

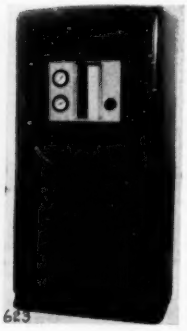
PROCESS MOISTURE MONITOR

New Type 26-310 is suited for monitoring moisture content of instrument airstreams and natural gas

transmission lines, moisture levels of feed streams in polymerization units, etc.; utilizes basic design by duPont: continuously and quantitatively absorbing and electrolyzing all water present in a sample stream entering instrument. Full-scale ranges from less than 1 ppm to 1000 ppm by means of a 5-step attenuator.—*Consolidated Electrodynamics Corp., 300 N. Sierra Madre Villa, Pasadena, Calif.*

For more information circle **207** on inquiry card.

CHLORINATOR

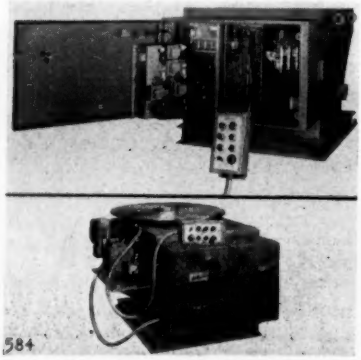


New Series A-721 chlorinator added to maker's line of V-notch equipment can meter and feed up to 8000 lb of chlorine per 24 hr. Feed rate can be adjusted manually or controlled automatically on a flow-proportional or selective-rate basis.—*Wallace & Tiernan Inc., 25 Main St., Belleville 9, N. J.*

For more information circle **208** on inquiry card.

WELD POSITIONER CONTROL

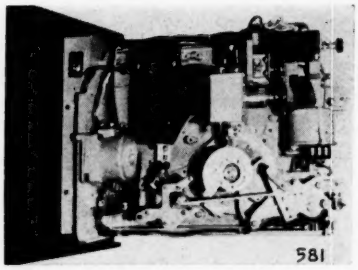
New EF-7871 Heavy Duty Precision Circumferential Weld Positioner and Motor Control is built for use with automatic fusion welding machines; permits operation of a precision welding positioner, providing an uninterrupted circumferential weld. Speed is held constant to 2½% at 60 rpm of motor shaft, ½% at 1800 rpm of motor shaft. This precision is directly proportionate, throughout entire 30 to 1 ratio, with 10% maximum line voltage variation.—*Weltronic Co., 19500 West Eight Mile Rd., Detroit 19, Mich.*



For more information circle **209** on inquiry card.

STRIP-CHART-RECORDER INTEGRATORS

New ball-and-disc integrators make possible a far greater number of read-out methods on strip chart recorders than without them. For integrating



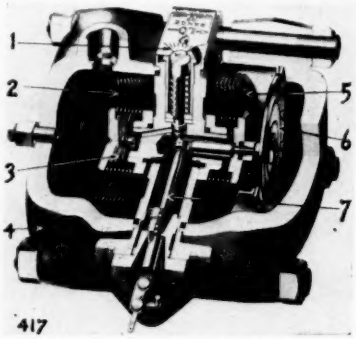
against time, a synchronous motor is provided and to integrate against inches the chart drive itself is used. Field and shop installation can be handled with new kits for most Brown and other makes of recorders.—*Royson Engineering Co., 100 North Penn St., Hatboro, Pa.*

For more information circle **210** on inquiry card.

FLOW-RATE, LIQUID LEVEL

MERCURYLESS FLOWMETER

New Type 37 Diaphragm Meter features highly-sensitive preformed diaphragms that "nest" for positive



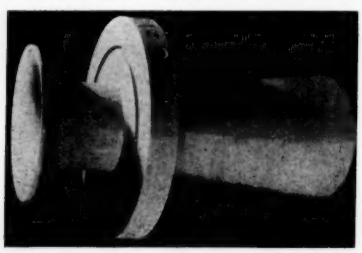
1—damping unit; 2—compensating diaphragm; 3—temperature compensator; 4—cover; 5—range diaphragm element; 6—range spring; 7—drive unit.

overrange protection to full static pressure. A bimetallic compensator inside high-pressure element varies this element's fluid capacity according to temperature changes of contained liquid. Differential ranges from 0-20" to 0-200" H_2O; maximum pressure 2000 psi.—*The Foxboro Co., Foxboro, Mass.*

For more information circle **211** on inquiry card.

PLASTIC VENTURI NOZZLE

New Model NZRP insert type Venturi flow nozzle, fabricated of fiberglass-reinforced polyester plastic, per-



mits metering many corrosive fluids; comes in line sizes from 2" to 24"; is suitable for pressures up to 150 psig and temperatures up to 250°F on most applications. Lab calibration can provide precise discharge coefficient and accuracy to 0.5%.—*Builders-Providence, Inc., 345 Harris Ave., Providence 1, R. I.*

For more information circle **212** on inquiry card.

FABRICATED FLOW NOZZLE

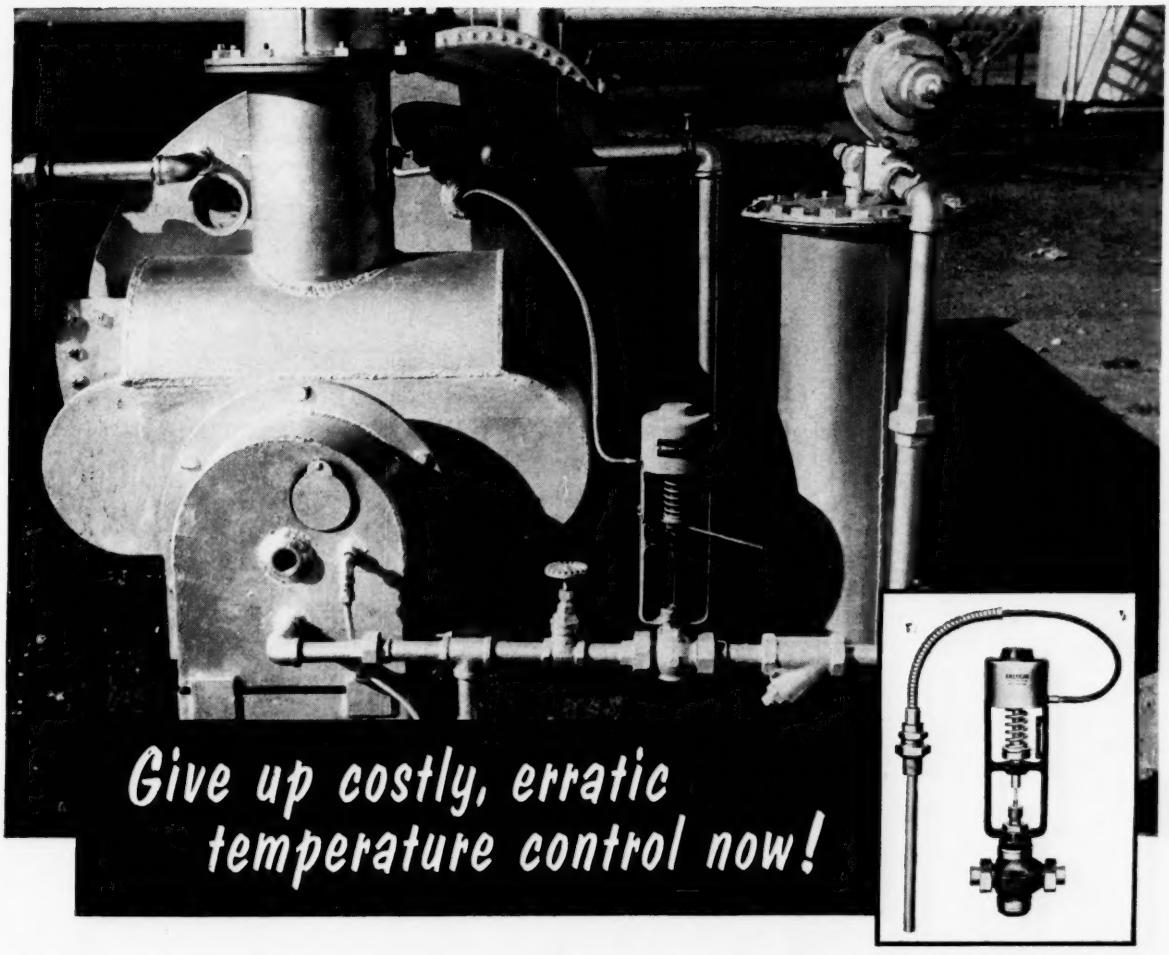
New non-corrosive fabricated flow nozzle is about one-fifth the weight of forged steel; can be delivered in less

than half the time required for forged steel; is made to ASME code; costs less than steel units in size above 8" and about the same as steel below 8".—*Penn Instruments Div., Burgess-Manning Co., 4110 Haverford Ave., Phila. 4, Pa.*

For more information circle **213** on inquiry card.

PRECISION ORIFICES

New precision drilled orifices can be ordered according to required flow-rate for a given system, eliminating inconsistencies caused by calling for a certain hole size in order to obtain a desired flow-rate of either a gas or a liquid. This availability of produc-



INSTALL 'AMERICAN' TEMPERATURE REGULATORS

Oil heaters and treaters . . . water heaters . . . diesel water jackets . . . dryers . . . ovens . . . plating tanks . . . washers . . . feedwater systems . . . air-compressor after coolers. Equipment of all kinds in all kinds of industries is seldom kept at required temperatures *when operated manually*. Result: a lot of money wasted every day.

Eliminate costly, erratic manual control—now! Get reliable overheat protection. American Temperature Regulators do a far better job than even the most skilled operators. They are self-operated, automatic—constantly maintain temperatures within required limits. Greater product uniformity is assured. Fuel and manpower are saved. Users find these sturdy, powerful regulators often pay back their cost 3 to 6 times a year. Many serve dependably 10 to 25 years!

Boost efficiency and economy wherever accurate temperature control is an everyday necessity. American Temperature Regulators are sensitive and responsive. Installation is simple. No compressed air or electricity needed. Temperature adjustment and repeat setting are easy. Sizes range from ¼" to 4". Get complete details. Write for Bulletin 112C.

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AMERICAN INDUSTRIAL INSTRUMENTS

A product of **MANNING, MAXWELL & MOORE, INC.** STRATFORD, CONNECTICUT

MAKERS OF 'AMERICAN' INDUSTRIAL INSTRUMENTS, 'CONSOLIDATED' SAFETY AND RELIEF VALVES, 'AMERICAN-MICROSEN' INDUSTRIAL ELECTRONIC INSTRUMENTS, *Stratford, Conn.* 'HANCOCK' VALVES, *Watertown, Mass.* 'CONSOLIDATED' SAFETY RELIEF VALVES, *Tulsa, Oklahoma.* AIRCRAFT CONTROL PRODUCTS, *Danbury & Stratford, Conn. and Inglewood, Calif.* "SHAW-BOX" AND 'LOAD LIFTER' CRANES, 'BUDGIT' AND 'LOAD LIFTER' HOISTS AND OTHER LIFTING SPECIALTIES, *Muskegon, Mich.*

For more information circle **57** on inquiry card.

Control it with Comvor®

DATA TRANSMISSION TERMINAL

RFL Model 912

Operates over Wire Circuit or Microwave

•

Reliable HIGH-SPEED Continuous Control

of

PUMPS
VALVES
MOTORS
GENERATORS
RELAYS
ETC.

The Model 912 Comvor, an audio frequency shift terminal, is used in the transmission of telemeter, telegraph or control signals over either wire line, microwave, or carrier. Up to 60 individual information channels are available in the audio spectrum.

Reliable frequency shift method of keying is used. All essential controls such as transmitter output level and receiver input level are included.

Each terminal contains its own power supply which provides an additional 60 milliamperes at both the transmitter and receiver for the operation of relays, stepping switches, selector magnets, and other components used in telemetering, control and telegraph applications.

WE CAN HELP YOU

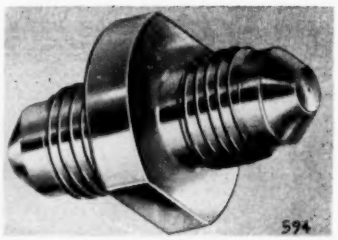
Our Applications Department is ready to assist you in your control, telemetering or communications problem. Phone DEerfield 4-3100.

Write for Technical and Application Data.

Radio Frequency
LABORATORIES, INC.
Boonton, New Jersey, U. S. A.

For more information circle **58** on inquiry card.

NEW INSTRUMENTS



tion quantities of precise flow restrictors makes hand-made orifices unnecessary.—*Del Mfg. Co.*, 1005 *S. Central Ave., Los Angeles* 21, *Calif.*

For more information circle **214** on inquiry card.

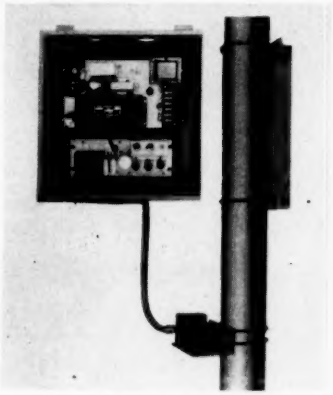
TANK OVERFILL ALARM

New Models TP or VO (for fixed-top or floating-top tanks) sound a gas-operated horn to give an extremely loud warning should liquid level in a tank exceed safe limits. Among claimed advantages: (1) non-electric operation; (2) simplicity of design, and flexibility; (3) easy installation and maintenance; (4) low cost; (5) reliability.—*Falcon Alarm Co. Inc., 243 Broad St., Summit, N. J.*

For more information circle **215** on inquiry card.

RADIATION-TYPE LEVEL MEASURING EQUIPMENT

New JSP-173A radiation-type level-measuring equipment, designed in cooperation with AEC, is never



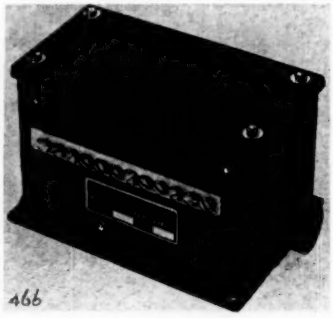
in contact with process material; cannot be affected by corrosive liquids; is easily installed; provides means of recording and controlling level of any process material from water or distillates to a slurry of finely crushed ore; range 6" to 48".—*Instruments, Inc., Tulsa, Oklahoma.*

For more information circle **216** on inquiry card.

TEMPERATURE

RESISTANCE THERMOMETRY SYSTEM

New system specifically designed for severe missile and aircraft test environments permits continuous

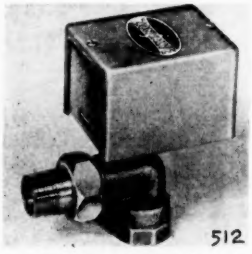


monitoring of temperatures at 12 points within missile. Its power comes from missile instrumentation supply. —*Arthur C. Ruge Assoc., Inc.*, 733 *Concord Ave., Cambridge, Mass.*

For more information circle **217** on inquiry card.

TEMPERATURE-CONTROL VALVE

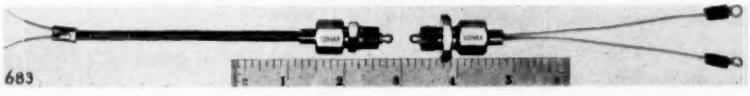
New Zonvalve thermostatically-controlled valve permits temperature control of individual plant areas,



zones or offices; is attached to radiator in place of ordinary radiator valve; can also be installed at any point on supply piping; utilizes low-voltage wire and requires no specialized electrical work for connections. —*Heat-Timer Corp., Dept.* 258, 657 *Broadway, New York* 12, *N. Y.*

For more information circle **218** on inquiry card.

MIDGET THERMOCOUPLE GLANDS



New complete line of midget thermocouple glands features positive seal for bare wire at pressures from 0.005 microns to 5,000 psi. Temperatures from −300°F to 1850°F; 63% lag less than one second.—*Conax Corp., 2300 Walden Ave., Buffalo* 25, *N. Y.*

For more information circle **219** on inquiry card.

WHAT'S NEWS AT BRISTOL . . .

Bristol Liquid Level Gauges keep tabs on unruly liquids

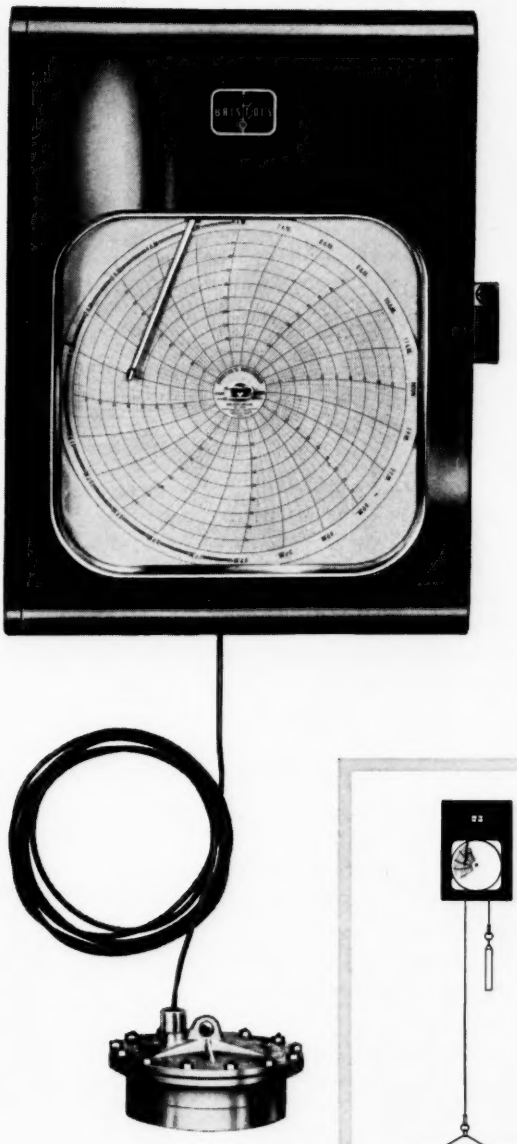
Measuring or controlling the levels of liquids can be quite a problem at times.

Especially if the liquid is flowing, turbulent, corrosive, covered with ice, carrying solid matter, or contained in a closed vessel where its surface is under static pressure.

Solving any of these problems is easy with a Bristol Liquid Level Gauge. These widely-used precision instruments indicate, record, and automatically control the level of almost any liquid without difficulty. They'll read in feet, inches, fathoms – any unit of measurement you desire.

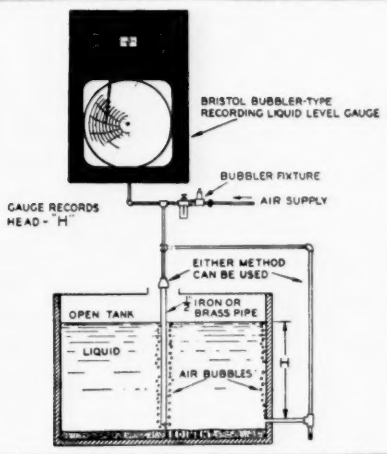
What's more, there's a standard Bristol Liquid Level Gauge for practically every application – including Float, Pressure Bulb, Pressure, and Bubbler type Gauges and Controllers. Our field engineers will gladly study your problem and make recommendations.

Write for complete information on the instrument that will fully meet your requirements. The Bristol Company, 113 Bristol Road, Waterbury 20, Conn. 5.15



PRESSURE-TYPE GAUGES for measurement and control of levels in open vessels can be adapted to any type of mounting.

FLOAT-TYPE GAUGES are designed to measure levels of large bodies of water such as supply reservoirs or lakes.



BUBBLER-TYPE GAUGES measure levels of corrosive and solid-carrying liquids like those in pulp mills or sewage plants.

BRISTOL

TRADE MARK BRISTOL'S REG U.S. PAT. OFFICE

POINTS THE WAY IN HUMAN-ENGINEERED INSTRUMENTATION

AUTOMATIC CONTROLLING, RECORDING AND TELEMETERING INSTRUMENTS

For more information circle **59** on inquiry card.

BISHOP TUBING

Can Take it!

That's why more and more aircraft, rocket and missile manufacturers are *specifying* BISHOP TUBING for engine parts and assemblies to withstand the corrosion, high temperatures, resistance to oxidation, vibration, stress and shock required by today's high speed aircraft.

Bishop Stainless Steel and Nickel Alloy Aircraft Grade Tubing excels in performance and endurance, and when required meets the rigid ASM, ASTM, MIL-T and AN-WW-T specifications.

You, too, can *specify* BISHOP TUBING on your next order.

Manufacturers of: Seamless and Welded and Drawn Stainless Steel Tubing (.008" to 1" OD), Mechanical, Capillary, Hypodermic and Aircraft Grade, Nickel and Nickel Alloy Tubing (up to .625" OD), Tubular Fabricated Parts, Glass-to-Metal Sealing Alloys, Clad Metals and Composite Wires, Platinum Group Metals and Chemicals. **Catalogs on Request**

JB

STAINLESS STEEL PRODUCTS DIVISION

J. BISHOP & CO. **Platinum Works**

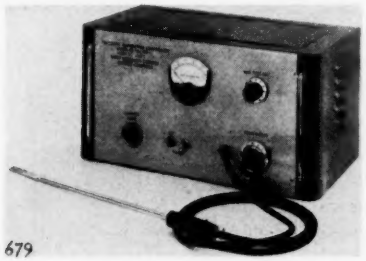
Malvern, Pennsylvania Tel.: Malvern 3100

Photograph of F-102A Interceptor Courtesy CONVAIR, a division of General Dynamics Corp., San Diego, California.

For more information circle **60** on inquiry card.

TEMPERATURE CONTROLLERS

New Models 102 (—100 to 100°C), 103 (—30 to 225°C) and 104 (200 to 500°C) feature 0.001 C° control ac-


679

curacy. Each unit is checked for 0.001 C° control capability on a test bath.—*Bayley Instrument Co., Box 538, Danville, Calif.*

For more information circle **220** on inquiry card.

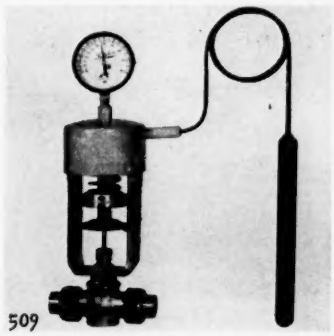
LANCE-TYPE THERMOMETER

New Model CTL Fluid-Temperature Indicator for liquids and bulk materials has stainless steel probe. Variation in design of probe and cable can be supplied. Only extreme tip of probe is heat-sensitive. Response time is about 2 sec. Automatic compensation for ambient temperature variations is included. Available ranges: 0-300, 0-450, 0-650, and 0-1000°F, each with a corresponding C scale.—*Royco Instruments, 720 Arthur St., Albany, Calif.*

For more information circle **221** on inquiry card.

TEMPERATURE REGULATOR

New PA-2 self-operated temperature regulator for use exclusively in


509

metal finishing processes features use of special metals and plastics, insuring long operating life and dependable performance. Available in seven valve sizes from ¼" to 1½" and several bulb sizes.—*Fulton Sylphon Div., Robertshaw-Fulton Controls Co., Box 400, Knoxville, Tenn.*

For more information circle **222** on inquiry card.

FOR MORE INFORMATION ON ANY OF THE PRODUCTS REPORTED IN THIS SECTION, CIRCLE THE ITEM NUMBER ON THE INQUIRY CARD BOUND IN THE BACK OF THIS ISSUE.

PRESSURE and VACUUM

PRESSURE STANDARD

New secondary standard for the calibration of pressure instruments, and for direct pressure measurements,

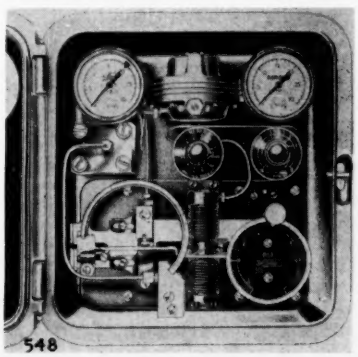
427

features over-all accuracy of 0.05% of full-scale ranges of 5 to 2500 psia or psid, and 0.1% for ranges of 3000 psi to 10,000 psig. Output, easily displayed on a frequency counter, is also suitable for recording in digital form.—*Wiancko Engineering Co. 255 N. Halstead Ave., Pasadena, Calif.*

For more information circle **223** on inquiry card.

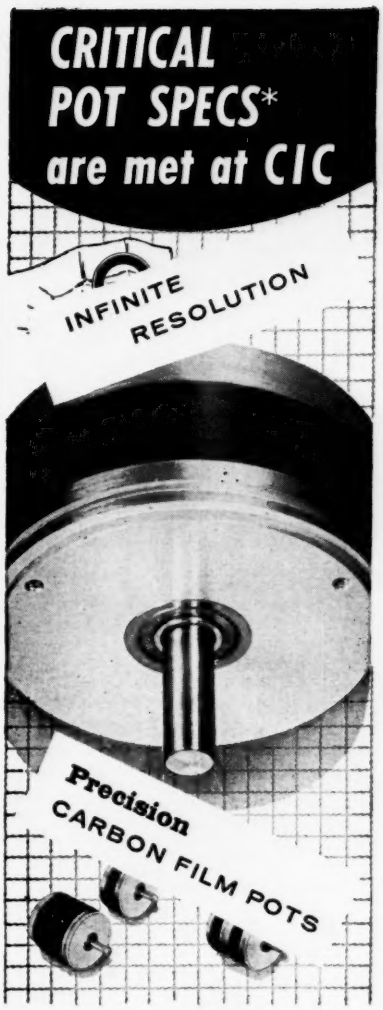
PRESSURE CONTROLLERS

New series of "Wizard" pressure controllers features flexibility: standard proportional controller can easily


548

be field converted to (1) two-position controller, (2) pressure transmitter, (3) controller with remote set, and (4) proportional plus reset controller. Universal case for wall-, panel- or yoke-mounting. Ranges from 25 to 10,000 psi.—*Fisher Governor Co., Marshalltown, Iowa.*

For more information circle **224** on inquiry card.



Equipment designers who demand more than "shelf item" specifications, rely on CIC for dependable delivery of ultra-precise potentiometers.

The result of CIC research, carbon film potentiometers are setting new standards of accuracy, life at higher speeds and performance reliability.

CIC has assisted many firms in a wide variety of industrial instrumentation, military fire control and flight guidance equipment.

Why not discuss your specific requirements with us?

*New carbon film techniques assure virtually infinite resolution; linearity to .01%, sine-cosine to .025%; compact ganging; precision ball bearing servo construction.

"For Precision Performance...specify CIC"

Detailed Technical Data Sheets available on request.

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92 Madison Ave. • Hempstead, Long Island, N. Y.

For more information circle **61** on inquiry card.

Waugh

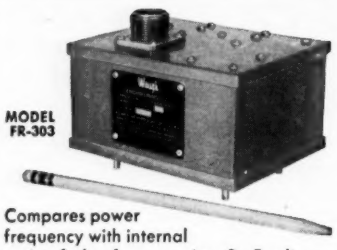
TRANSISTORIZED FREQUENCY-to-VOLTAGE CONVERTERS

MEASURE AND CONTROL:

• Flow Rate • R.P.M.
• Power Frequency
• Linear Speed

MODEL FR-302 SUBMINIATURE CONVERTER

Detects AC signals down to low amplitude levels, converts to 0—5 volt DC signal proportional to frequency within .2%, gives .25% long term stability with less than .002% per degree temperature coefficient.



MODEL FR-303

Compares power frequency with internal tuning fork reference, gives 0—5 volts DC between 370 and 430 cps, with .05% overall accuracy under severe vibration and temperature conditions.

20 standard modifications of the FR-300 series converters are available to suit every airborne and ground requirement.

TURBINE FLOWMETERS

...covering flow rates from .065 to 6000 GPM... are standard testing equipment in the newest missiles and aircraft, where the ultimate in reliability and accuracy are required.

Write for Complete Data

STanley 3-1055

Waugh ENGINEERING COMPANY

FLOW MEASUREMENT AND CONTROL
7842 BURNET AVENUE, VAN NUYS, CALIFORNIA

For more information circle **62** on inquiry card.

NEW INSTRUMENTS

DIFFERENTIAL PRESSURE CONTROLLER

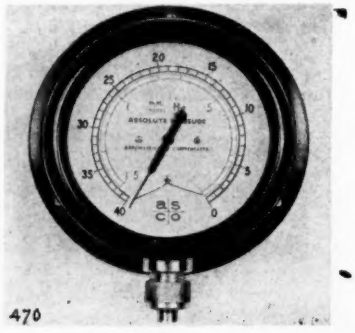
New Model 237 Controller features maker's Model 199 rupture-proof bellows unit; is available in DP ranges

from 0-20" wc to 0.50 psi, static pressure ratings up to 6000 psi, various housing materials. Standard control actions include on-off, differential gap and proportional (optional: proportional plus reset or proportional plus rate). Supply pressure 20 psi; output 3-15 psi (6-30 psi optional).—*Barton Instrument Corp., 580 Monterey Pass Road, Monterey Park, Calif.*

For more information circle **225** on inquiry card.

ABSOLUTE PRESSURE GAGES

New Accu-Vac capsule-type absolute pressure 4"-dial indicators can be flush-mounted on instrument

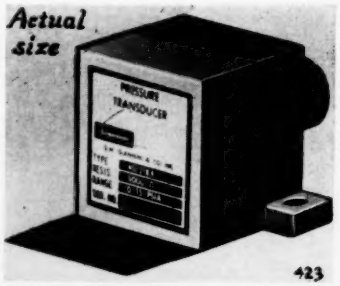


panels, or directly mounted into line by use of threaded or rubber tubing couplings provided with each instrument; are protected against sudden pressure changes within a system, as well as against corrosive gases. Accuracy 0.2%.—*Arthur F. Smith Co., 311 Alexander St., Rochester 4, N. Y.*

For more information circle **226** on inquiry card.

PRESSURE PICKUP

New Model 451218, weighing less than 3 oz., has performance characteristics similar to units many times larger and heavier. Its voltage output (to 50 v) in most cases can be used

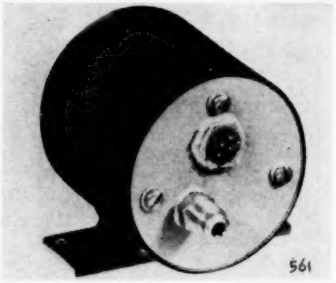


without amplication. It is available in pressure ranges from 0-15 to 0-50 psia, psig or psid, with resolution of 0.33% (300 wires) and linearity better than 1.5% of full-scale output.—*G. M. Giannini & Co., Inc., 918 E. Green St., Pasadena 1, Calif.*

For more information circle **227** on inquiry card.

PRESSURE PICKUP

New Model 22005 meets need for high-sensitivity absolute-pressure measurements; is for use with non-

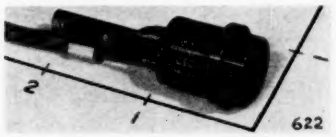


corrosive or slightly corrosive fluids. Resolution 0.0002 or better; hysteresis better than 0.3%, repeatability better than 0.3%; high-temperature operation; low vibration and steady-state acceleration error.—*Physical Measurements Corp., 1650 19th St., Santa Monica, Calif.*

For more information circle **228** on inquiry card.

HIGH-TEMPERATURE HIGH-G PRESSURE PICKUP

New Type 4-317 is available in nine ranges from 0-100 to 0-5000 psig; can be operated continuously at



5 v max input between −350°F and 600°F with allowable transients up to 750°F. Linearity and hysteresis deviations combined are less than ±1.5% f-s. Acceleration and vibration are cancelled by geometry and winding arrangement of star-spring 4-arm-bridge unbonded-wire sensing elements, and have little net effect on bridge output. Allowable acceleration is 100 *G* in any axis.—*Consolidated Electrodynamics Corp., 300 N. Sierra Madre Villa, Pasadena, Calif.*

For more information circle **229** on inquiry card.

Here G. D. Schott (right), Flight Controls Department head, discusses computer solutions of control and guidance problems with E. V. Stearns (center), Inertial Guidance Department head, and J. E. Sherman, Analog Computer Section head.

Lockheed Missile Systems announces new positions in

MISSILE FLIGHT CONTROLS — *the creative field for engineers*

Few fields equal missile systems flight controls in the need for original thinking. The ever-increasing performance of missiles presents problems that grow constantly in complexity. At Lockheed, weapon systems programs demand important advances in flight controls. Emphasis is on new ideas, new techniques.

Positions are open on the Sunnyvale, Palo Alto and Van Nuys staffs for engineers possessing strong ability and interest in: Research and development of advanced flight control systems for controlling missiles and rockets; system synthesis by application of control system feedback techniques; analysis and design of nonlinear servo systems; development of transistor and magnetic amplifier techniques in the design of advanced flight control systems; analysis and simulation of the dynamic performance of the guidance – autopilot – airframe combination; development of systems utilizing advanced types of inertial and gyroscopic instruments; analysis and design of hydraulic servo systems for controlling missiles at high Mach numbers; environmental and functional testing of prototype flight control systems.

Inquiries are invited from engineers possessing a high order of ability. Address the Research and Development Staff, Sunnyvale 1, California.

Lockheed **MISSILE SYSTEMS** . A DIVISION OF LOCKHEED AIRCRAFT CORPORATION

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MODULIZED

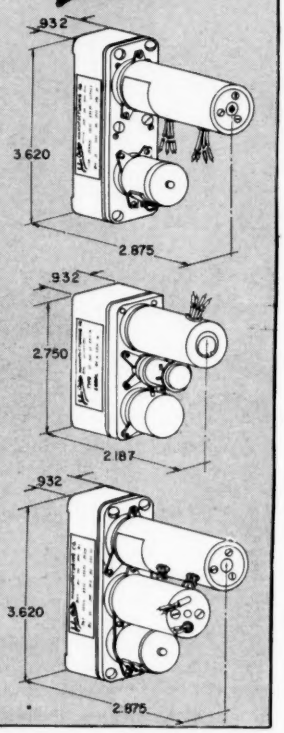
SERVO SYSTEMS

QUICKLY INTERCHANGEABLE . . . EASILY SERVICED

- Miniaturized
- Lightweight
- Simple, fast installation
- Meets MIL-E-5272
- Can be hermetically sealed with dimensional changes

OSTER TYPE	SB-9805-01	SB-9805-02	SB-9805-03	SB-9805-11
Motor				
Fixed Phase Voltage	26v	115v	115v	26v
Control Phase Voltage	26v	115v	115v	26v
Frequency	400	400	400	400
Max. Power @ Stall	6	5	5	6
No Load Speed	10,500	10,000	10,000	10,500
Generator				
Excitation Voltage Phase 1	26v			26v
Output Phase 2	0.3v/1000 RPM 100,000 ohm load			0.3v/1000 RPM 100,000 ohm load
Null	.012v			.012v
Wobble Voltage	.007v			.007v
(Power Excitation)	3.5 watts Max.			3.5 watts Max.
Linearity	0.5% to 4000 RPM			0.5% to 4000 RPM
Potentiometer				
Mechanical Rotation	360°	360°	360°	360°
Resistance	1000 ohms	50,000 ohms	50,000 ohms	1000 ohms
Accuracy of Total Resistance	±5%	±5%	±5%	±5%
Electrical Angle	350°	350°	350°	350°
Servo Block Unit				
Ambient Temperature	−55°C to 72°C	−55°C to 72°C	−55°C to 72°C	−55°C to 72°C
Altitude	−1000 feet to 55,000 feet	−1000 feet to 55,000 feet	−1000 feet to 55,000 feet	−1000 feet to 55,000 feet
Life	3000 hours excluding pot.	3000 hours excluding pot.	3000 hours excluding pot.	3000 hours excluding pot.
Gear Train				
Ratio	1000 : 1	336 : 1	167 : 1	10,000 : 1
Dust Enclosed per	Section 4.11 MIL-E-5272A	Section 4.11 MIL-E-5272A	Section 4.11 MIL-E-5272A	Section 4.11 MIL-E-5272A
Backlash	Anti-Backlash gear on pot.	1°	1°	Anti-Backlash gear on pot.
Synchro				
Input Voltage—Stator	11.8v			
Output Voltage—Rotor	10.6v			
Clutch Brake				
Input Voltage		100v dc	100v dc	
Input Power		2.0 watts Max.	2.0 watts Max.	
Operate Time—Energize		5 milliseconds	5 milliseconds	
Operate Time—De-energize		20 milliseconds	20 milliseconds	

Oster®



Offered as illustrated with identical or different combinations of:

gear ratios	servo
clutch	synchro
brake	motor-tach
clutch-brake	potentiometer

Write for further information TODAY, enclosing details of your requirement.

Other products include motor-gear-trains, synchros, AC drive motors, DC motors, servo mechanism assemblies, motor tachs, servo torque units, reference and tachometer generators, actuators, motor driven blower and fan assemblies and fast response resolvers.

John Oster **MANUFACTURING COMPANY**
Your Rotating Equipment Specialist
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Engineers For Advanced Projects:
Interesting, varied work on designing transistor circuits and servo mechanisms. Contact Mr. Zelazo, Director of Research, in confidence.

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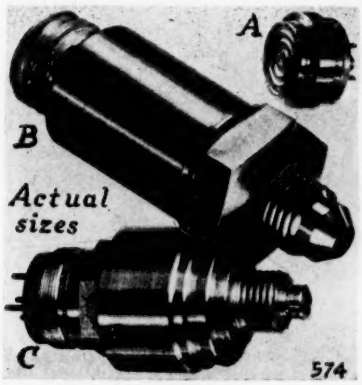
For more information circle **64** on inquiry card.

PRESSURE PICKUPS

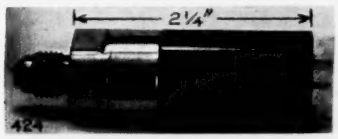
Three new pressure pickups of strain-gage-bridge type: (A) miniature flange-mounted model combining high output (25 to 100 mv full scale depending on pressure range) with high accuracy (0.5% full scale with 0.25% hysteresis). (B) Model PT45 is completely compensated for sensitivity, zero balance, zero drift due to temperature, sensitivity change due to temperature, input impedance, and output impedance. Result is extradordinary consistency of performance. (C) High-pressure miniature Model PT32 excels where large pressures (to 15,000 psi) must be measured with minimal alteration of pressure chamber. Diaphragm (0.2" OD) can be mounted flush with chamber. Over-all accuracy (including hysteresis) within 1% full scale.—*Dynamic Instrument Co., 28 Carleton St., Cambridge, Mass.*



For more information circle **230** on inquiry card.

PRESSURE PICKUP

New Model S-9 variable-reluctance single-coil diaphragm-type pressure pickup is similar to Model S-6A except that it is temperature-compensated over the range of −65°F to 230°F. It is designed for use as the variable inductor in reactance-controlled FM/FM subcarrier oscillator. Can be provided with linear or nonlinear pressure versus inductance curves. Range 5-1000 psia, psig or psid.—*Ultradyne Engineering Labs., Inc., P. O. Box 3308, Albuquerque, N. Mexico.*

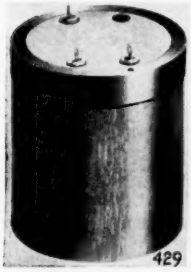


For more information circle **231** on inquiry card.

ACCELERATION, FORCE, WEIGHT, etc.

ACCELERATION PICKUP

New Model 7-31 offers temperature-controlled damping without use of a heater. Temperature range −55°F to 200°F with less than 1% calibration shift. Acceleration ranges ±0.5 G through ±150 G (or any included non-symmetrical range) with maximum resolution of 0.25% Case dimensions 1⅞" D x 2.22" H.—*Edcliff Instruments, P. O. Box 307, 1711 South Mountain Ave., Monrovia, Calif.*



For more information circle **232** on inquiry card.

WEIGHING-SYSTEM CONTROL

New console comprises a control panel and a cabinet for housing control elements of maker's weighing system. Its listing and adding unit digitally indicates weight data originating at remotely located scale (or scales); it controls various weighing operations. If a total or subtotal of weights is desired, operator presses a button and receives this figure. It is possible also to preset number of cycles and allow system to operate through this number automatically. As each cycle is completed, number is registered on digital indicator.—*Toledo Scale Co., 1079 Telegraph Rd., Toledo 1, Ohio.*

For more information circle **233** on inquiry card.

PUNCHED CARD SYSTEM FOR BATCH WEIGHING

New Punched Card Reader (PCR) System, integrated with an automatic proportioning panel, increases accuracy and speed of batch weighing by taking formulation out of operator's hands. It uses punch cards (21-section type) coded for prescribed batching formulas. Operator inserts card into PCR unit, pulls locking lever and presses start button. All the rest is

for RELIABLE MONITORING in Hazardous Locations...

EXPLOSION-PROOF ANNUNCIATORS (Type EKP-4)

Wherever processes or systems in hazardous locations must be monitored with unwavering safety, consider Scam Explosion-Proof Annunciators. These rugged alarms provide a sturdy housing that is approved for Class I, Division I, Group D locations.

INCLUDES ALL THESE SCAM FEATURES:

- **Four alarms in one housing...requires little piping, low installation costs!**
- **Standard for "Sequence A" (visual-audible), other sequences on special order!**
- **All relays mounted on plug-type jack . . . for maintenance just plug spare jack into housing!**
- **Only four holes required for easy panel mounting!**

For Constant Protection for **Your** *Monitoring Needs,* **Choose a Scam Explosion Proof Annunciator.**

For special Explosion Proof Systems, consult with us or one of our representatives.

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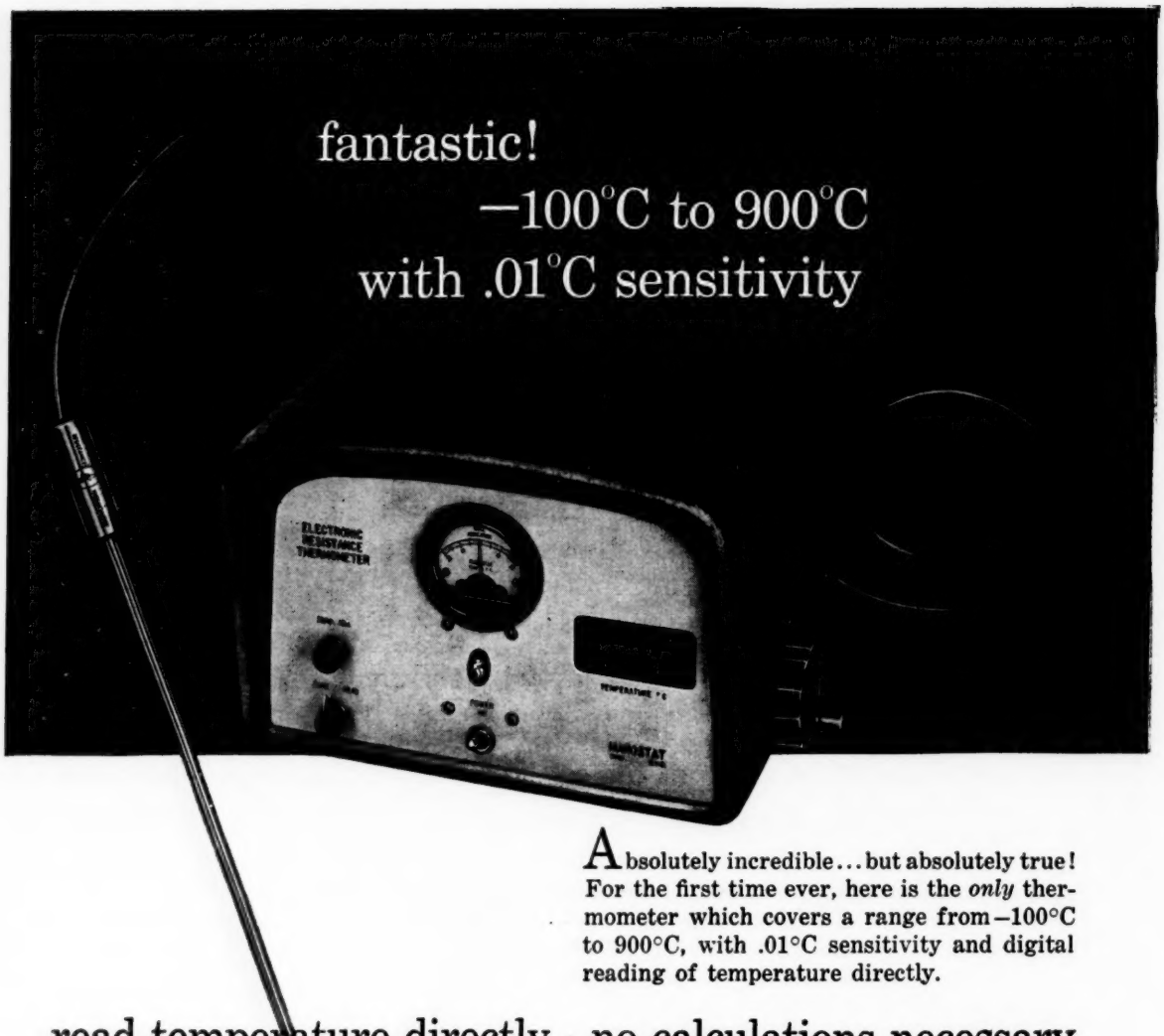
For more information circle **65** on inquiry card.



Absolutely incredible... but absolutely true! For the first time ever, here is the *only* thermometer which covers a range from —100°C to 900°C, with .01°C sensitivity and digital reading of temperature directly.

read temperature directly · no calculations necessary

- ▶ High Accuracy
  .10°C up to 400°C .20°C up to 900°C
- ▶ Each resistance bulb and bridge individually calibrated.
- ▶ Vacuum sealed platinum elements and leads in resistance bulb:
  - Hermetically sealed head
  - Choice of stainless steel or quartz jacket
- ▶ Plug-in controller accessory with .05°C reproducibility.

ELECTRONIC Resistance Thermometer

HOW IT WORKS:

By means of a special circuit in the Wheatstone bridge, the reading of the balancing variable resistor is made to follow a second degree relationship corresponding with the change in resistance of platinum with temperature. This gives a direct reading instrument which eliminates the time consuming calculations normally required with high precision resistance thermometry. A high sensitivity electronic detector permits rapid and precise balancing of the bridge.

PRICE LIST:

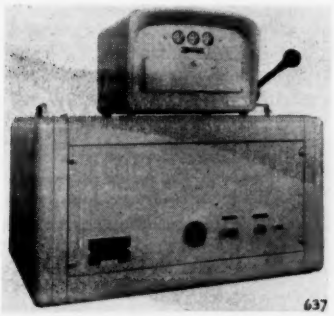
23525	Electronic Resistance Thermometer without bulb. Either 23525D or 23525E or both must be ordered at the same time as the thermometer and these will be individually calibrated	1105.00
23525D	Stainless Steel Bulb, only	395.00
23525E	Quartz Bulb, only	395.00
23525F	Temperature controller, only	112.50

The EMIL GREINER Co.

For Complete Information Write For Bulletin

20-26 N. MOORE STREET, DEPT. 230, NEW YORK 13, N. Y.

For more information circle **66** on inquiry card.



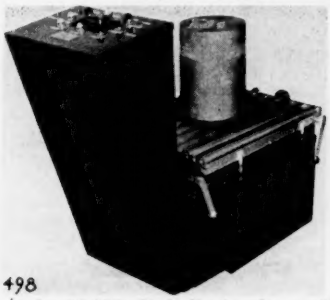
637

automatic, with exact cycling of any number of bulk materials through various stages of weighing, discharge, mixing and conveying away for bagging. Operator can repeat a given formula any desired number of times. Inventory totalizer records amount of each ingredient used as well as total delivered per hour, shift or day. —*Richardson Scale Co., Clifton, N. J.*

For more information circle **234** on inquiry card.

CHECKWEIGHING SCALE

New automatic checkweighing scale, originally constructed for expensive chemicals, is accurate to 1



498

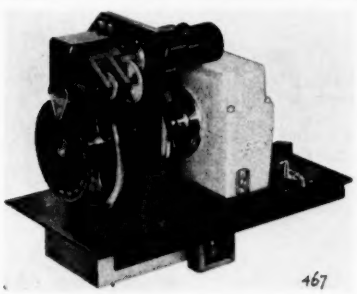
part in 10,000. It indicates by a direct-reading register in decimal system, in pounds or grams, and can be furnished with a ticket printer, chart recorder, remote indicators, conveyor for automatic control, etc.—*Thayer Scale Corp., Thayer Park, Pembroke, Mass.*

For more information circle **235** on inquiry card.

COMPUTING and DATA PROCESSING

AN-DIG CONVERTER

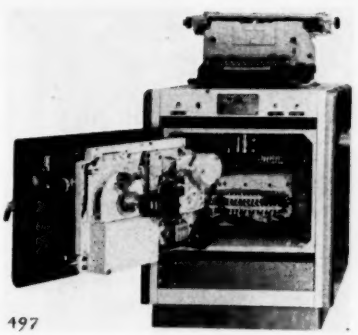
New "SI-1004 Servo Digitizer" can digitize into a binary-decimal code any physical magnitude (flow,



467

pressure, temperature, speed, etc.) represented by a 400-cps voltage in phase with the line. It is servo-driven and it positions a binary-decimal encoder. Scale factor and phase control knobs permit input command voltage to be exactly matched.—*Industrial Controls Co., 805 Albin Ave., Lindenhurst, L. I., N. Y.*

For more information circle **236** on inquiry card.



497

print-out of off-limit variables, digital printing timer, and thermocouple linearizing and cold-end compensation.—*Hanson Gorrill-Brian, Inc., 85 Hazel St., Glen Cove, L. I., N. Y.*

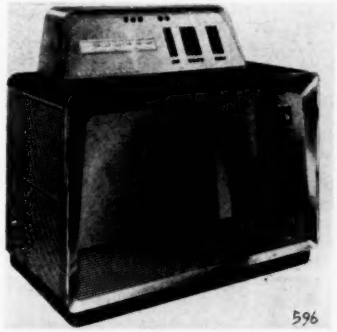
For more information circle **237** on inquiry card.

DATA LOGGER

New Model I Data-Master automatizes recording of data in process industries, labs, and testing facilities; will sequentially log up to 50 analog variables, continuously, on demand or at timed intervals; can present data in tabular form on a typewriter, or on punched cards for further processing. Standard models record outputs of strain gages, thermocouples, etc. Optional features include high and low limit alarms, red

DIGITAL DATA SYSTEM

New S-100 Digital Data Processing and Recording System, capable of sampling inputs from one to 100



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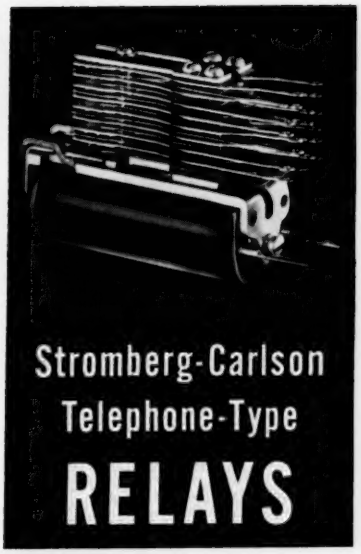

for industrial applications

PROMPT SHIPMENTS

For any part of your operation that depends on electromechanical switching, these "telephone-quality" relays by Stromberg-Carlson will provide unsurpassed reliability.

Proven by many years of meeting the exacting demands of the telephone industry, Stromberg-Carlson twin-contact relays are now available for industrial application.

These "telephone-quality" relays are available in many types, of which the following are representative:

Type A: a general-purpose relay especially adapted to the control of switching operations. Approximate size: $2^{21}/_{32}$" high, $7/_{8}$" wide with 20 Form "A" springs (maximum).

Type B: a gang-type relay—$2^{21}/_{32}$" high, $2^{7}/_{8}$" wide—which can be equipped with 60 Form "A" spring combinations (maximum). The Type BB relay accommodates up to 100 Form "A" spring combinations. Size: $2^{25}/_{32}$" high, $4^{7}/_{8}$" wide.

Type C: two relays on the same frame; mounts in the same space as the A type. It is especially effective where space is at a premium.

Type E: *interchangeable with many other makes.* It combines the time-proven characteristics of the A relay with a new universal mounting arrangement common to many other brands.

Complete specifications of all Stromberg-Carlson relays are contained in Bulletin T-5000R, available on request.

S-C STROMBERG-CARLSON

STROMBERG-CARLSON

A DIVISION OF GENERAL DYNAMICS CORPORATION

TELECOMMUNICATION INDUSTRIAL SALES

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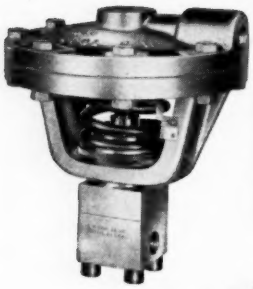
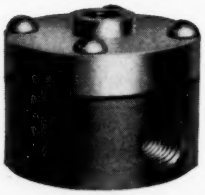
For more information circle **67** on inquiry card.

MINIATURIZATION From Pilot Plant to Process



"BANTAM" 500 SERIES VALVE

Throttling "Bantam" Diaphram Control Valves for all standard control valve uses, Cv of 0.6 and below, up to 1000 psi and 500°F, characterized, renewable trim, 316 stainless steel and *Teflon* only wetted surfaces, low in hysteresis size and weight, 2000 series "Bantam" Control Valves available for on-off service.

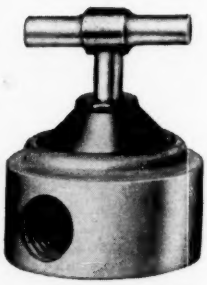


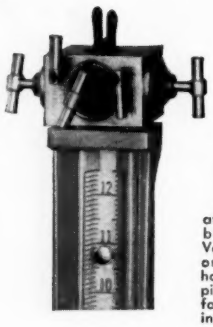
MINIATURE DIAPHRAGM OPERATED SHUT OFF VALVE

Body PVC, diaphragm neoprene, diaphragm head aluminum. Body and operator 2" dia. x 1¾" high. (⅛ or ¼ NPT).

"DEMI" PACKLESS VALVE

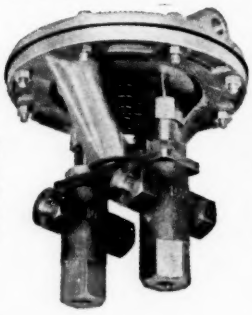
For services when packing is a problem, manifolding of small valves in one unit at low cost. For services up to 750 psi and 500°F, screw, toggle, or diaphragm operated, the "DEMI" line is ideal for panel mounting up to five valves in one block.





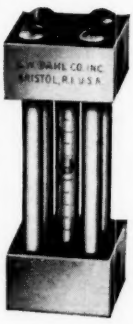
"DEMI 54"

5 Valve Manifold for integral mounting on cleanout type Manometer. Packless design, 2 shut off valves, one bypass valve, 2 vent valves. Other 3 or 5 valve models available with or without special manometer mounting.



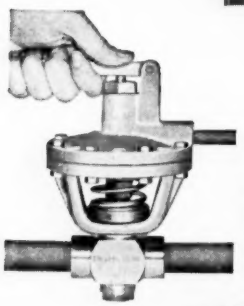
WHIFFLETREE OPERATOR

Two valves operated simultaneously by one operator. Valves may be globe or three-way and have a multitude of piping arrangements for mixing and routing applications.



AIR RATE INDICATOR

Top and bottom housing, 1¼" square anodyzed aluminum barstock, combination column studs and gauge protection. The ⅛" IPS ports may be relocated by removing column studs and rotating top or bottom housing. Standard calibration indicates 0 to 2 standard cubic ft. per hour of air. Other models available with built-in toggle actuated packless valves or needle type valves for precise control or special porting or additional ports to suit your requirements.



MANUAL RESET

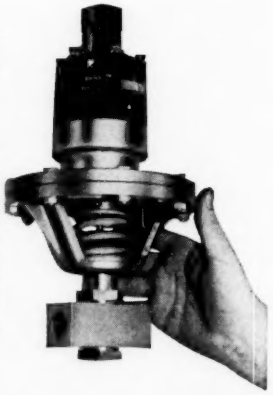
Wherever control air on dangerout or toxic process flows must be blocked for safety, on air failure until manually reset, these valves insure against disaster. Standard sizes ¼" and ½" I.P.S.

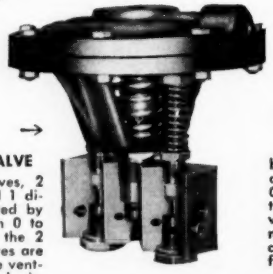
SAUNDERS VALVE, AIR OPERATED

Plastic valve, 2" and below, metal valve 1" and below. G. W. Dahl Co., Diaphragm Operators on these valves provide simple, sure automatic operation. Each application must submit full flow information.

MINIATURE THROTTLING CONTROL VALVE, TOP MOUNTED MOORE POSITIONER

Compact, accurate rugged. High lift, positioning accuracy, low cost, and low in weight and size. Body, bonnet and blind head of barstock construction. Valve sizes up to 1", screwed or flanged. Trim Cv, 12.0 to 0.001. Pressures, 0 to 2000 psi. Temperatures, Minus 400 to Plus 1000°F.



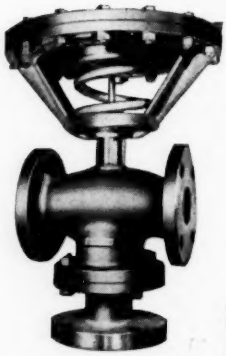


BLOCK VENT VALVE

3 balanced valves, 2 reverse acting and 1 direct acting, actuated by one operator. With 0 to 3 psi control air, the 2 reverse acting valves are closed, center valve vented. At 6 psi control air, all valves closed. At 12 to 15 psi, the 2 reverse acting valves are open and the vent valve is closed, allowing free flow through body. Design pressure 1000 psi. *Teflon*, Chevron packing. *Teflon* seating for tight shut off.

DIAPHRAGM OPERATED 3-WAY CONTROL VALVE

Aluminum diaphragm operator, stainless steel body and trim, *Teflon* packing with *Teflon* seating for tight shut off. Available up to 2", flanged or screwed.



MINIMUM DISPLACEMENT PACKLESS VALVE

Designed specifically for minimum hold-up in valving capillary tubing. 1¼" dia. body available with special bonnet for solenoid or diaphragm operation, or hand operation.

REPRESENTATIVES IN PRINCIPAL CITIES

Write us for complete technical information, or for the address of our representative in your area.

GEORGE W. DAHL COMPANY, INC. 86 TUPELO STREET, BRISTOL, R. I.

For more information circle **68** on inquiry card.

Vibrotron Digital Transducers, at rates of up to 100 per second, delivers measurement input as directly-digital information, either sequentially or upon demand. Etched circuitry throughout component groups and plug-in type fabrication minimize operating interruptions. System outputs include visual readout, tabulations, punched cards, tape and other output media. Output provisions for process monitoring and control can also be incorporated. Power requirements: 115 v; 60 cps.—*BJ Electronics, Borg-Warner Corp., 3300 Newport Blvd., Santa Ana, Calif.*

For more information circle **238** on inquiry card.

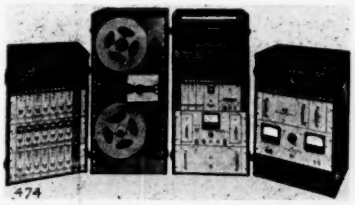
BALLISTIC COMPUTER

New Type K-1 Ballistic Computor, used in development of guided missiles, automatically displays such parameters as ignition delay, action time, integrals of thrust and pressure, as well as peak values. It can be supplied for printout on paper tape or on cards. It contains tape recording equipment and a play-back analyzer section.—*Allegany Instrument Co., Inc., 1091 Wills Mountain, Cumberland, Md.*

For more information circle **239** on inquiry card.

MAG-TAPE SYSTEM

New transportable Series 3000 300 kc bandwidth Recordata multi-channel magnetic tape recording system features selection, either remotely or from front panel, of six speeds (1⅞ to 60 ips) with appropriate equalization built-in to automatically compensate for each speed. It accommodates reel sizes up to 14" standard (19" and continuous loop versions are also available.)—*Recordata Div., American Electronics, Inc., 655 W. Washington Blvd., Los Angeles 15, Calif.*

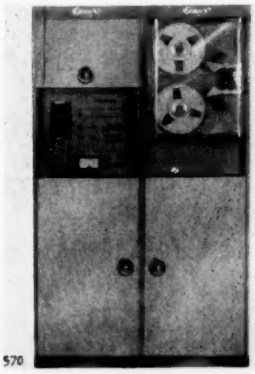


474

For more information circle **240** on inquiry card.

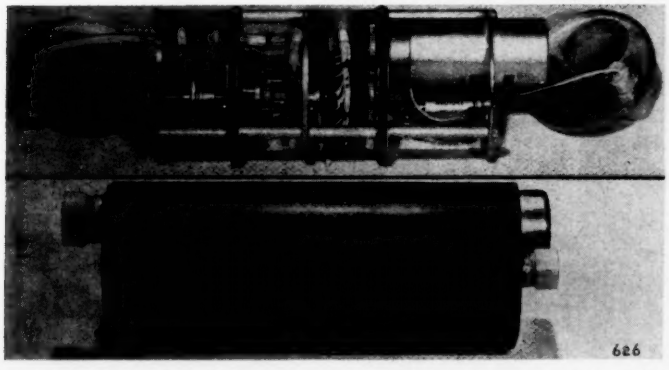
MAG-TAPE SYSTEM

New Model DR-704/711 CompuCorder prepares digital test data on magnetic tape in exact computer format; gathers asynchronous digital in-



570

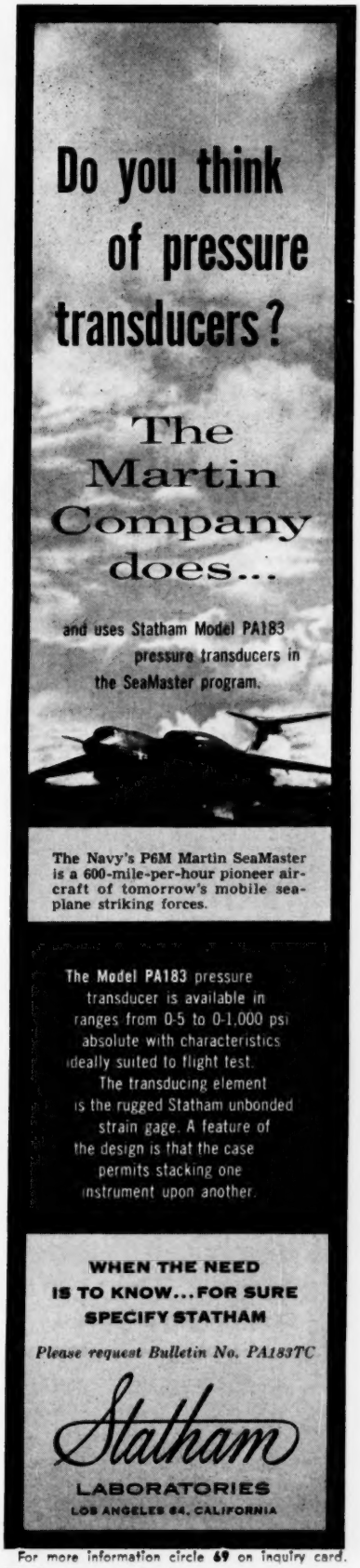
BINARY TIME CODE GENERATOR



626

New DATEX Model DC-103 produces a serial output of one synchronizing pulse followed by eight bits of binary coded dc timing signals per second. Total number of unique binary coded time signals produced is 128. DC-103 is designed to be airborne and to withstand 30-*G* shock on any axis. Temperature range −65°F to 170°F.—*G. M. Giannini & Co., Inc., 918 E. Green St., Pasadena 1, Calif.*

For more information circle **241** on inquiry card.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The Martin Company does...
and uses Statham Model PA183 pressure transducers in the SeaMaster program.
The Navy's P6M Martin SeaMaster is a 600-mile-per-hour pioneer aircraft of tomorrow's mobile seaplane striking forces.
The Model PA183 pressure transducer is available in ranges from 0-5 to 0-1,000 psi absolute with characteristics ideally suited to flight test. The transducing element is the rugged Statham unbonded strain gage. A feature of the design is that the case permits stacking one instrument upon another.
WHEN THE NEED IS TO KNOW... FOR SURE SPECIFY STATHAM
Please request Bulletin No. PA183TC
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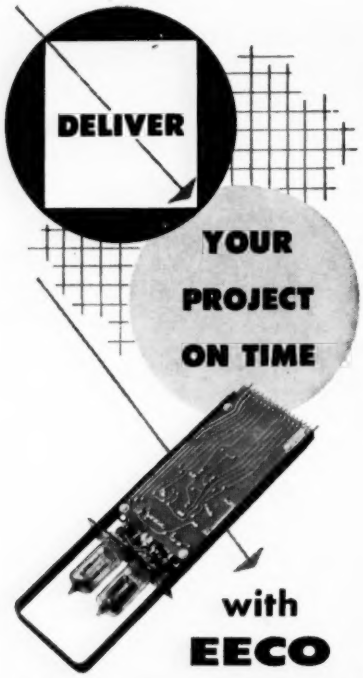
For more information circle **69** on inquiry card.



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COMPUTER-SERIES
PLUG-INS

Originally developed for EECO custom systems and proven in critical use, new EECO Computer-Series Plug-ins represent a refinement of the building-block concept to a degree hitherto unknown. Each of the full line of reliable, tested, and proven circuits is a complete off-the-shelf packaged function, performance-engineered for application where ultra-conservative design at the component level is essential because of system complexity.

New EECO Computer-Series Plug-ins enable you to meet your project delivery schedules by reducing systems-development time to a bare minimum and practically eliminating drafting and layout time. Your engineers can concentrate on system design instead of routine circuit detail. Your technicians can cut fabrication time and step up production by performing simple point-to-point wiring instead of wiring complex circuits. And system prototypes can generally be built directly without need for the "breadboard" stage.

Detailed information on Computer-Series Plug-ins, Standard-Series Plug-ins, Systems Development Racks, Power Supplies, D-C Amplifiers ...and other EECO products is available in Catalog No. 856-A. Write for your copy—today.

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of California
506 EAST FIRST STREET
SANTA ANA, CALIFORNIA

For more information circle **70** on inquiry card.

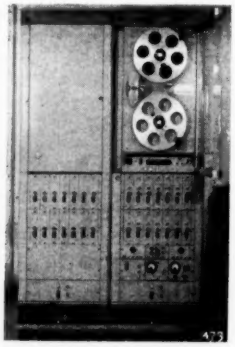
NEW INSTRUMENTS

formation from several external sources and combines them in any selected sequence together with record numbers and manually inserted fixed data. Not only can data sequence be arbitrarily selected, but tape format and gap length can also be varied.—*Epsco, Inc., 588 Commonwealth Ave., Boston 15, Mass.*

For more information circle **242** on inquiry card.

MAG TAPE SYSTEM

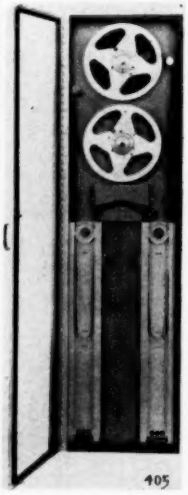
New 14-channel magnetic tape recorder/reproducer system is suitable for research studies requiring high-



speed acquisition of large amounts of precise data. It accepts data directly from sources such as RDB telemeter receivers and PDM equipment; also signals from self-generating pickups, bridge-type strain gages, etc., when transmitted through amplification equipment.—*Consolidated Electrodynamics Corp., Pasadena, Calif.*

For more information circle **243** on inquiry card.

TAPE TRANSPORT

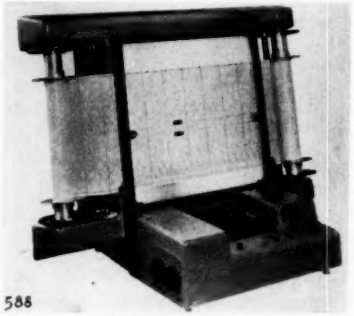


New Model 546-53368 10-speed magnetic tape transport for electronic data processing systems provides 60:1 speed ratio (1.5 to 90 ips); selects any speed by remote or local control; uses ¾" tape wound on 10½" reels. Start-stop time is 6 milliseconds. Tape's oxide surface touches only three stationary members, one of which is magnetic head. During rewind, tape is automatically removed from head. Exact end-of-tape sensing by two vacuum manifolds which detect arrival of perforated leaders and trailers.—*Electrodata Div., Burroughs Corp., 460 Sierra Madre Villa, Pasadena, Calif.*

For more information circle **244** on inquiry card.

RECORD READER

New OSCARette semi-automatic record reader features speed, simplicity and low price, hence is ideal in



data reduction situations where a limited number of points are to be read over a long trace record. Where much computing is to be done, it is peculiarly applicable because it reads out on a fixed numeric scale.—*Applications Engineering Dep't, Benson-Lehner Corp., 11930 W. Olympic Blvd., Los Angeles 64, Calif.*

For more information circle **245** on inquiry card.

TAPE PERFORATOR

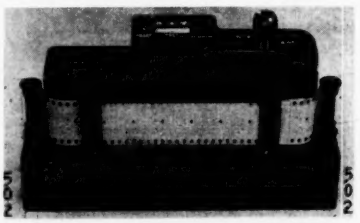
New Model 701 comprises punch head, motor drive, diode coding system, scanning circuits, power supply

and special chassis and housing unit. It accepts parallel input signals of straight decimal coding which are scanned for correct positioning in perforated format. While digits are scanned, they are coded into desired form.—*Clary Corp., 408 Junipero St., San Gabriel, Calif.*

For more information circle **246** on inquiry card.

FILM TRANSPORT

New Model TF-400 offers unique advantages for data processing and evaluation systems. Its new design is



CRESCENT ARMORED MULTITUBE *for Underground runs*

gives lowest cost with permanence for Instrument and Control Tubing

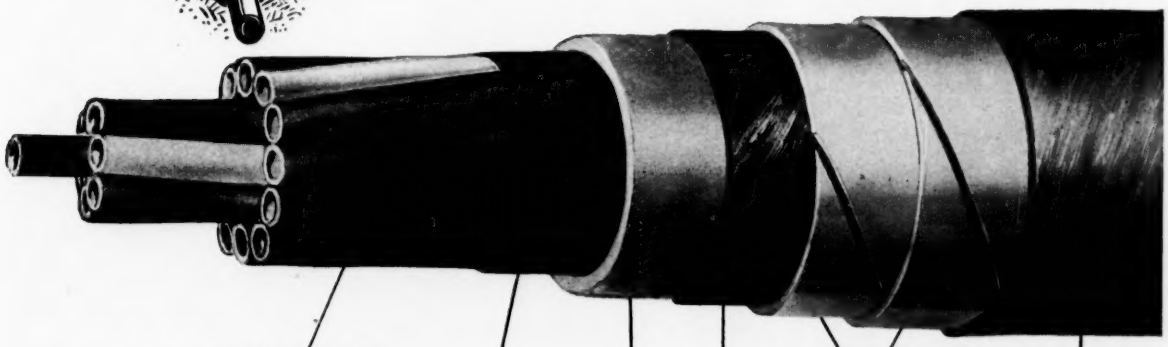
This construction of CRESCENT ARMORED MULTITUBE® may be laid in a deep trench for long underground runs without any further protection other than that offered by its lead sheath, asphalted jute, two layers of heavy galvanized flat steel armour with an asphalt impregnated jute outer covering.

The economy of this method is obvious. Also the copper tubes are completely safe from mechanical injury, and the thick asphalted jute coverings protect the metal from moisture, corrosion, earth acids and alkalies. Under road crossings where very heavy traffic is encountered, it may be buried in concrete poured into the bottom of the trench or it may be pulled through conduit.

Up to 37—¼" O.D. copper tubes may be furnished in this and several other forms of CRESCENT ARMORED MULTITUBE, one of which should best suit your installation requirements at substantial cost savings and resulting in a better protected job.

Licensed under U. S. Patent 2,578,280.

For Further Information Send for NEW Engineering Bulletin No. 356-A.



CRESCENT INSULATED WIRE AND CABLE CO.

TRENTON, NEW JERSEY

For more information circle **71** on inquiry card.

BOURDON TUBING

ACCURATE ONE INCH TO ONE MILE

Constant wall thickness . . . consistent spring properties . . . exact duplication . . . whether a "C", a helix, or a spiral—Precision Bourdon Tubing meets all these requirements. Precision's modern production facilities offer you instrument tubing to meet your most exacting specifications—tubing preformed or straight.

Precision also offers Coaxitube, a metal shielded wire consisting of an inner conductor, insulation and seamless non-ferrous metal tubular shield forming a coaxial pair of conductors. Semi-rigid equivalents to all RG/U cables.

Write for full details on "Precision Tubing For Precision Instruments" to Dept. 3, Precision Tube Corporation, North Wales, Pa.

PRECISION TUBE COMPANY

For more information circle **72** on inquiry card.

NEW INSTRUMENTS

interchangeable and compatible with film viewers already in service. Four synchronized functions: (1) Usual intermittent function; (2) "Flo-Film" mode of operation; (3) Rewind position; (4) Shift from one function to the other during transport of film without losing synchronization between pilot pins and drive mechanism.—*Richardson Camera Co.*, 171 *W. Magñolia Blvd., Burbank, Calif.*

For more information circle **247** on inquiry card.

TIME, SPEED, COUNT

TIME METERS

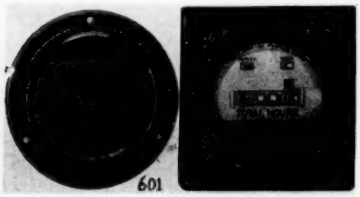
New KT time meters feature automobile-type counter which makes them more than twice as easy to read

as former design. Square or round cases, 2½" or 3½" sizes; portable stand for use where permanent mounting is not desirable; sealed model for military use; also protective conduit case for outdoors. All models measure either hours and tenths or minutes and tenths. Ratings include 120, 240, or 480 v at 60 or 50 cps.—*General Electric Co., Schenectady 5, N. Y.*

For more information circle **248** on inquiry card.

TIME METERS

New Alternating Current Hour Meters are available in 2" round or square non-ferrous fully-insulated



cases; 120, 240 and 480 v; 50 or 60 cps (25 cps to order); 10,000 hr (with tenths in red on white) or 100,000 hr; specially-designed permanently-sealed life-lubricated motor unaffected electrically by low voltage.—*John W. Hobbs Corp., Div. Stewart-Warner, Springfield, Ill.*

For more information circle **249** on inquiry card.

SMALL STROKE COUNTER

Newly redesigned Junior King Small reset 4-digit stroke counter has die-cast cover with chrome-plate finish; and mounting holes in cover prevent disassembly for tampering without complete dismounting.—*Production Instruments Div., General Controls Co., 8068B McCormick Blvd., Skokie, Ill.*

For more information circle **250** on inquiry card.

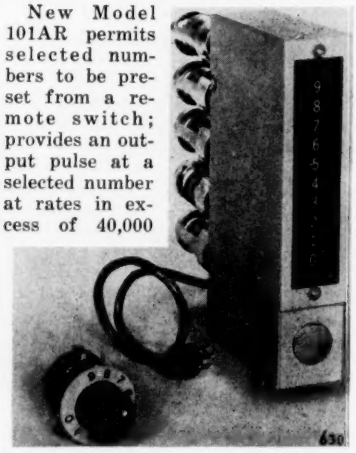
STEPLESS SPEED CONTROLLER

New Revtrol converts 230-v ac to half wave dc; automatically provides exact amount of torque up to 100% as required by load. This automatic torque supply is available at all speeds from normal nameplate reading to practically zero or standstill speed. Change-over of a machine from an ac constant-speed motor drive to infinite-speed-range drive is relatively simple and reversing switch can be used if required. Control units are now available for 1/6, ¼, ⅓, ½ and ¾ hp.—*Acme Electric Corp., Cuba, N. Y.*

For more information circle **251** on inquiry card.

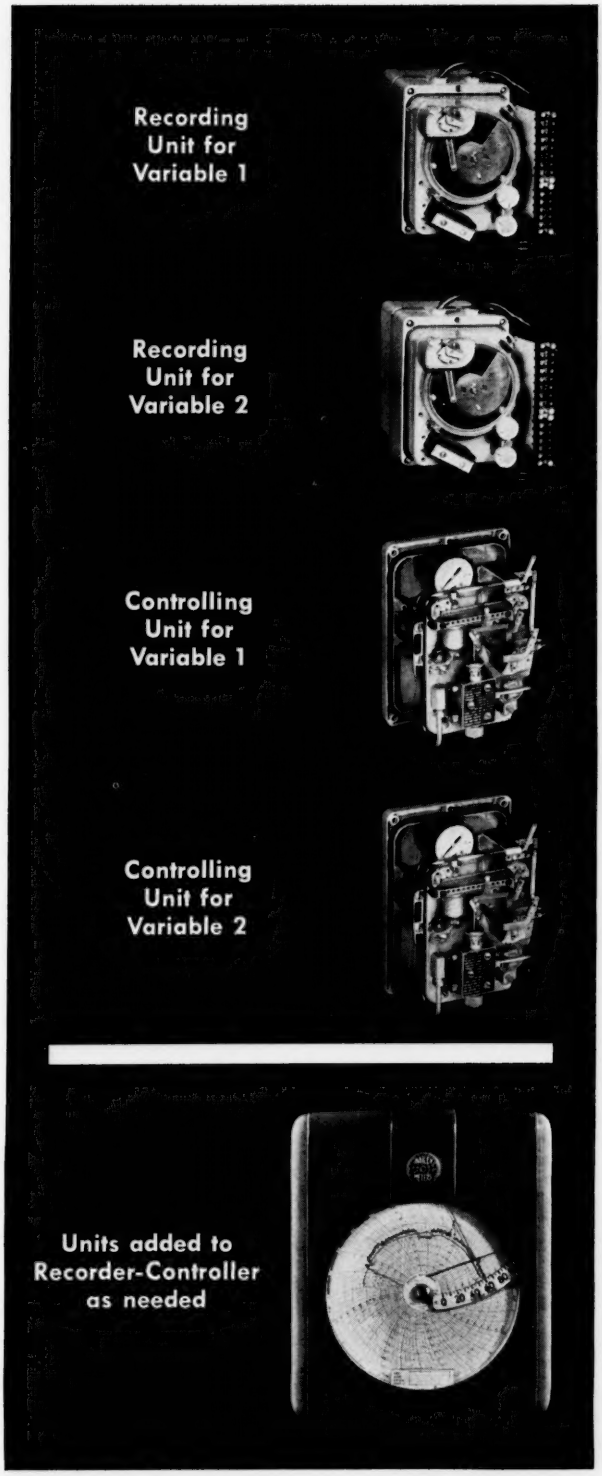
REMOTE PRESET COUNT UNIT

New Model 101AR permits selected numbers to be preset from a remote switch; provides an output pulse at a selected number at rates in excess of 40,000



counts per second (if reset is not required, 100,000-cps rate). Units can be cascaded to emit a pulse at any desired count. Pulse output at 0 reset; Model 101BR offers a 9 reset; Model 101CR has 4 line 1-2-3-4 coded output, 0 reset for operation of digital printers, etc.—*Computer Measurements Corp., 5525 Vineland Ave., North Hollywood, Calif.*

For more information circle **252** on inquiry card.


Recording Unit for Variable 1
Recording Unit for Variable 2
Controlling Unit for Variable 1
Controlling Unit for Variable 2
Units added to Recorder-Controller as needed

Bailey Recorder is key to "step-by-step" automation

When you are pioneering a new process and don't know all the answers, complete automation is seldom practical. The first step is to identify your variables and measure them. Nothing does this job better than a Bailey Recorder. One instrument can record any four variables that can be converted to electric *or* pneumatic signals.

Once you get a better understanding of the variables in your process, you will want to add controls and feed back your measurements. Here's where the versatility of the Bailey Recorder comes into play. For the same Bailey instrument you use to record variables is designed to accommodate plug-in control units.

When you use a Bailey Recorder, you can build your instrumentation along with your process. At the start, you use only the plug-in units for recording. Then you add plug-in controls as you see the need for them.

For the complete story of how you can use a Bailey Recorder for step-by-step automation, see your Bailey Engineer.

G-42-1

Instruments and controls for power and process

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BAILEY METERS

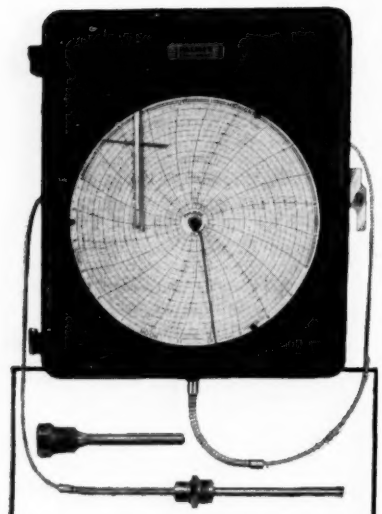
For more information circle **73** on inquiry card.

PALMER

MERCURY ACTUATED

recorders

Into this modern Mercury Actuated Recorder has gone all the skill of Palmer master craftsmen.



Readings are clearer, smoother and more precise than ever thought possible. In fact readings are so amazingly improved that maintenance is never needed under normal uses.

Recording Thermometers feature twelve inch die-cast aluminum case with black wrinkle or white satin finish. Single or multiple pen construction. Electric or spring wound clock, 24 hour or 7 Day Revolution. Flexible Armor and bulb of stainless steel. Ranges —40 to 1000°F. or Equivalent in °C.

Send for Bulletin No. 45

Consult your Classified Directory

PALMER

THERMOMETERS, INC.

Mfrs. of Industrial Laboratory, Recording and Dial Thermometers

Cincinnati 12, O.

For more information circle **74** on inquiry card.

LABORATORY EQUIPMENT

HIGH-VACUUM PUMP

New Type EI-2000A Evapor-Ion Pump, said to be the only device available that creates a "dry" vacuum

in the range from 10^{-4} to 10^{-8} mm Hg, utilizes an electronic method for producing high vacuum without use of organic pump fluids: it pumps active gases by the gettering action of evaporated titanium wire, and pumps inert gases by ionizing and burying them under a layer of titanium. Pumping speed 1900 lps for nitrogen, 1000 for oxygen, 3000 for hydrogen. It also pumps many other gases, including water vapor, at high speed. No refrigerated traps or baffles are required. Mechanical forepressure pumping for continuous operation is not needed.—*Rochester Div., Consolidated Electrodynamics Corp.*, 1775 *Mt. Read Blvd., Rochester 3, N. Y.*

For more information circle **253** on inquiry card.

FLOW COLORIMETER

New ratio recording flow colorimeter for continuous analysis of any color in visible spectrum is unique in that it makes possible the accurate measurement of wavelengths from 0.35 to 1.00 micron in presence of turbidity or entrained gas, through use of a specially designed light-beam splitter based on principle of a single-beam instrument. In addition, it is relatively insensitive to source variations and to accumulation of foreign matter on cell windows of analyzer section.—*Process Instruments Div., Beckman Instruments, Inc.*, 2500 *Fullerton Rd., Fullerton, Calif.*

For more information circle **254** on inquiry card.

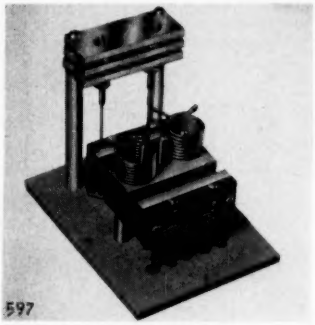
LAB FLASKS

New 500-cc filtering and Erlenmeyer flasks of high-temperature polyethylene, now available for the first time, are extra-heavyweight; are chemically resistant at high temperatures; have a high softening point.—*Palo Laboratory Supplies, Inc.*, 81 *Reade St., New York 7, N. Y.*

For more information circle **255** on inquiry card.

CHROMATOGRAPHY CELL

New detector cell for gas chromatography is said to be the most sensitive ever for all temperature ranges. It



will operate continuously at 200°C and is balanced to give superior sensitivity at both high and low temperatures. It signals minute traces as low as 1 ppm and fractional ppm following specified techniques. Signal-to-noise ratio is extremely high.—*Burrell Corp.*, 2223 *Fifth Ave., Pittsburgh 19, Pa.*

For more information circle **256** on inquiry card.

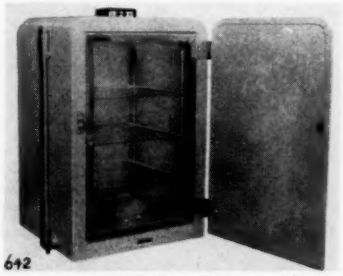
MICROLITER PIPETTES

New line of six types of Pyrex brand glass Lambda-Pettes for paper chromatography conforms to ACS proposed specs and tolerances for micropipettes. Five types are calibrated to content, and available in various sizes in volumetric, self-filling and self-adjusting transfer, a graduated and a Lang-Levy type; sixth is an all-glass syringe type control with glass tip. All sizes and types are available in Handi-Paks of 12.—*Schaar & Co.*, 7300 *W. Montrose Ave., Chicago 34, Ill.*

For more information circle **257** on inquiry card.

INCUBATORS

New models of maker's water-jacketed incubators feature thermal



protection by Safety-Stat double hydraulic thermostat; fiberglass circulation of walls and outer doors; temperature range from 2 C° above room temperature to 65° C.—*National Appliance Co.*, 7634 *S. W. Capitol Hwy., Portland, Oregon.*

For more information circle **258** on inquiry card.

NEW!

1/4-WATT insulated hot molded composition resistor only 1/4" long!

Here's a new ¼-watt, *insulated* composition resistor in a truly *small* size . . . ONLY ONE QUARTER OF AN INCH LONG . . . that provides the same superlative performance, reliability, and uniformity which have made the Allen-Bradley hot molded resistor preferred the world over.

Although exceptionally small, Allen-Bradley Type CB hot molded resistors are rated for "continuous operation" at 70°C ambient temperatures. The hot molded construction of this Type CB resistor makes impregnation unnecessary . . . it also provides the most reliable protection against extended periods of high humidity, as encountered in practical applications. Available in all RETMA resistance values from 47 ohms to 22 megohms. Tolerances: 5%, 10%, and 20%.

Where space is at a premium . . . and where failures would be disastrous . . . you owe it to yourself to investigate this new addition to the Allen-Bradley *quality* line. Please write today for complete specifications. Samples available for your tests.

Allen-Bradley Co.
1315 S. First St., Milwaukee 4, Wis.
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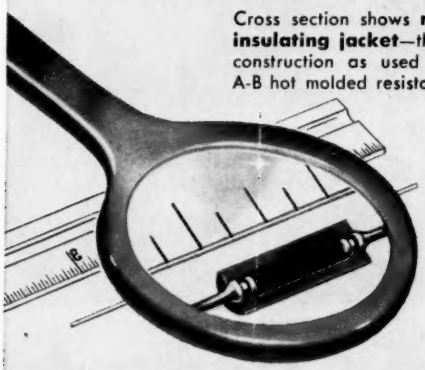
A-B QUALITY



Cross section shows **molded insulating jacket**—the same construction as used for all A-B hot molded resistors.

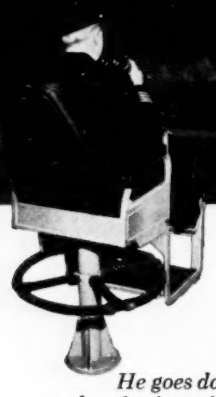
OTHER HOT MOLDED RESISTORS IN THE A-B FAMILY

Allen-Bradley fixed, molded resistors rated at 70°C ambient are available in standard RETMA values from 2.7 ohms to 22 megohms in ½ and 1-watt sizes . . . and from 10 ohms in the 2-watt size. In 5%, 10%, and 20% tolerances.

Allen-Bradley solid-molded resistors are packaged for either automatic or manual assembly. A-B carton packaging prevents bent or tangled leads. Pressure sensitive tape used to hold resistors in place on reels —for most economical assembly.

ALLEN-BRADLEY
HOT-MOLDED COMPOSITION RESISTORS
QUALITY

For more information circle **75** on inquiry card.



Sentinel in Navy Blue

He goes down to the sea in ships, does business in great waters.

But no longer is the Navy confined to the sea's surface. It plumbs the depths, ranges through the skies, penetrates outer space. Its laboratories, even a thousand miles inland, are nautical battle stations.

Research by the Navy, and by the industries which serve it, anticipates tomorrow's needs. Among the industrial leaders contributing to that research and translating Navy needs into production realities, are eight companies of the GPE Group.

Typical of the significant contributions by GPE companies are Librascope's computers and anti-submarine devices . . . GPL's automatic bombing and self-contained navigation system for the Martin Seamaster . . . Griscom-Russell distillation equipment on every class of ship including nuclear powered craft. An indication of Askania's, Kearfott's and Link Aviation's involvement is given in the adjoining column.

Many GPE Group products serve vital defense needs today. The scientific advances they embody will one day benefit everyone.

GENERAL PRECISION EQUIPMENT CORPORATION

PRINCIPAL PRODUCING COMPANIES • Askania Regulator • GPL • Graflex • Griscom-Russell
Hertner Electric • Kearfott • Librascope • Link Aviation • Pleasantville Instrument • Precision Technology • Shand and Jurs • Simplex Equipment • Strong Electric

For more information circle **76** on inquiry card.

praenuntius futuri

"Portrait of The Future" is the well-chosen motto of this submarine. States U. S. Naval Institute Proceedings: "The *Albacore* will long be remembered as the pioneer design for flying under water." *Albacore's* revolutionary piloting technique was conceived and produced by Askania, a GPE company.

Link Aviation provides still another glimpse into the future with its F-11-F Flight Simulator in which pilots of the supersonic Tiger *pre-experience* flight conditions and maneuvers, "log" priceless familiarization time. Also "shipping out" with the Navy Air Arm is Kearfott, providing 400-cycle components for both planes and guided missiles.

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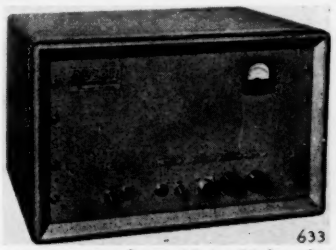
ULTRASONIC PROCESSING TANKS

New 5-gal and 8-gal Sonitanks, operating at a resonant frequency of 20 kc, feature a new method of attaching reinforced transducer elements by riveting, whence extreme ruggedness and greatly increased efficiency in conversion of ultrasonic energy.—*General Ultrasonics Co., 67 Mulberry St., Hartford 3, Conn.*

For more information circle **259** on inquiry card.

ULTRASONIC GENERATOR

New Model 2025 continuously delivers 250 watts (conservative rating) into a resistive load over frequency range from 12 to 50 kc. Output impedances can be obtained at 38, 75, 150 and 300 ohms. Generator can be used for either piezoelectric or magnetostrictive units.—*Alcar Instruments, Inc., 17 Industrial Ave., Little Ferry, N. J.*



For more information circle **260** on inquiry card.

ULTRASONIC GENERATOR

New Model AP-25-B Sonogen was designed for use with maker's standard tank-type or all-welded stainless steel immersible transducers; is said to be ideal for unattended and quick cleaning of small parts. Rated rf output is 125-watt average power, 500-w peak power on pulses.—*Branson Ultrasonic Corp., 40 Brown House Road, Stamford, Conn.*

For more information circle **261** on inquiry card.

ULTRASONIC CLEANER

New WC-17 low-cost three-stage system makes ultrasonic cleaning stations practical along production lines. It washes, rinses, and dries precision parts; can be used with almost any combination of solvents; cleans most parts in seconds; operates at about 35 watts at 1 Mc; provides suitable power for dispersion, degassing, agitation, chemical reaction study, and aging experiments.—*McKenna Labs., 2503 Main St., Santa Monica, Calif.*

For more information circle **262** on inquiry card.

ROTARY DIVIDING TABLES

New precision circular tables are available in plain rotary and tilting styles, in 7 sizes between 10" and 40" dia. Tables are graduated in degrees over full circle. To insure constant accuracy, tables are furnished with a circumferential compensating cam, whose contour is determined by optical testing.—*Opto-Metric Tools, Inc., 137 Varick St., New York 13, N. Y.*

For more information circle **263** on inquiry card.

VACUUM RETORT FURNACE

New Type CT-25 self-contained unit for processing small parts in a vacuum or protective atmosphere features a vacuum retort satisfactory for temperatures up to 2000°F at a vacuum of 0.5 micron or better. Work is heat-treated and cooled in the same tube. "Package" comprises furnace, auto-

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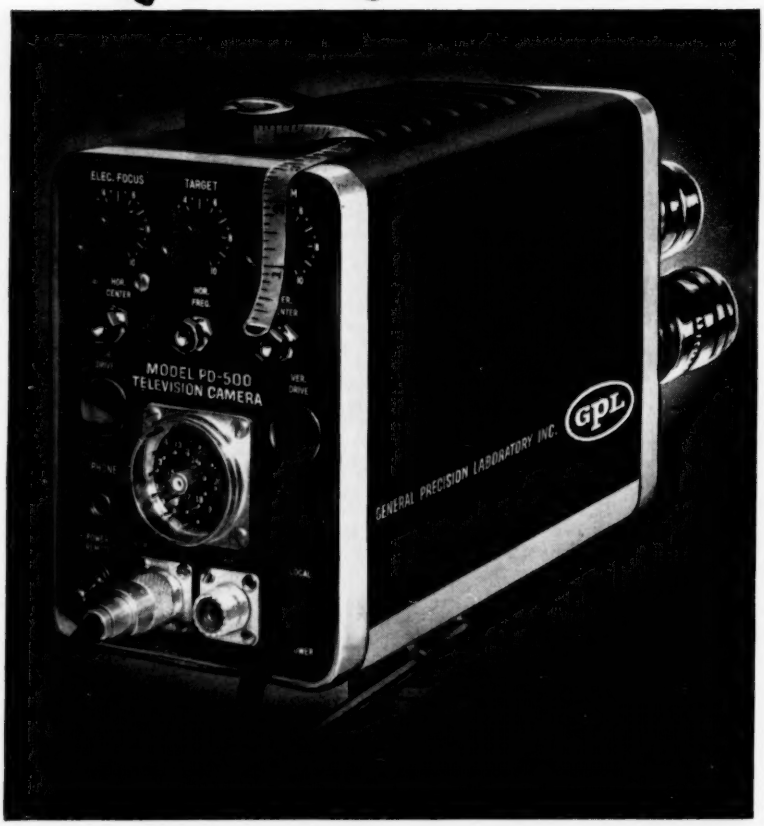

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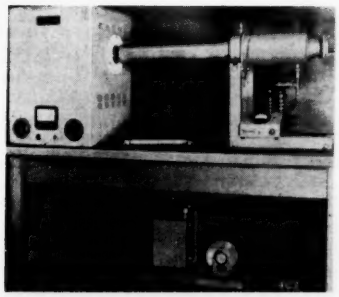
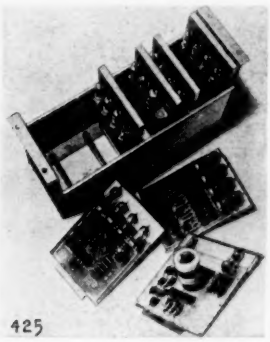


matic controller, pyrometer, 3" ID tube with water-jacketed cooling chamber, track and accessories for inserting tube into heat zone, 7" work boat, mechanical vacuum pump, diffusion pump and vacuum gage.—*Lindberg Engineering Co., Pilot Plant Div., 2321 W. Hubbard St., Chicago 12, Ill.*

For more information circle **264** on inquiry card.

COMPONENT CARDS

New plug-in 6" x 8" etched-circuit component cards permit more flexible breadboard design, faster develop-



ment time and reduction in over-all data processing and computer system costs.—*BJ Electronics, Borg-Warner Corp., 3300 Newport Blvd., Santa Ana, Calif.*

For more information circle **265** on inquiry card.

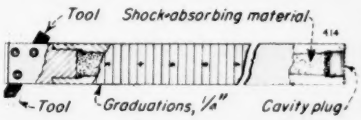
CENTERLESS GRINDER

New TG-12 Centerless Grinder is announced as "the most versatile and accurate machine yet offered to the machine tool field" for the centerless grinding of materials from tungsten carbide to cork. In two- and three-shift production, tolerances of 0.0002" are easily achieved and 6-8 microinch finishes consistently proved. TG-12 handles work from 0.004" to 1½" dia.—*Royal Master, Inc., 111 State Highway 23, Riverdale, N. J.*

For more information circle **266** on inquiry card.

CHATTERLESS BORING BAR

New Silent Sam makes it possible to take bigger smoother cuts and run work through faster on any lathe or



boring mill. Its inside is bored out from both ends to various sizes, with smallest size in middle to minimize harmonic vibration. Cavity is filled with a shock-absorbing material, under a vacuum, producing a dead bar.—*Pensco Products, 527 Lexington Ave., New York 17, N. Y.*

For more information circle **267** on inquiry card.

CAP SHELLS

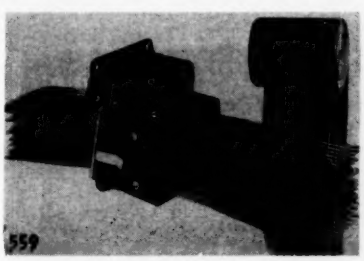
New N-Capshells, for encapsulation of components, are custom machined of polyester or epoxy ma-

terials; are available open-ended or with one end closed. Entry holes for leads are provided in closed end when specified. Their use obviates use of molds; reduces rejection rate and patch time.—*E. P. M. Corp., 675 Barbey St., Brooklyn, N. Y.*

For more information circle **268** on inquiry card.

FLEXIBLE PRINTED CABLE

New type of flexible printed cable, made of silicone rubber with or without glass reinforcement and with



shielding available in cover coat, can be produced in any length and in various conductor patterns. It is designed for Graphik Cable Harness System but engineered to individual requirements. ★ New pressure type connectors for 600°F service, also for Graphik Cable Harness System, have low contact resistance and 10 to 150 contacts with a wide range of contact ratings within a single connector.—*Cinch Mfg. Corp., 200 So. Turnbull Canyon Rd., La Puente, Calif.*

For more information circle **269** on inquiry card.

HIGH-TEMPERATURE SEALS

New Ceramicite C-200 high-temperature material will hermetically seal to Type 300 stainless steels. Its thermal expansion matches that of

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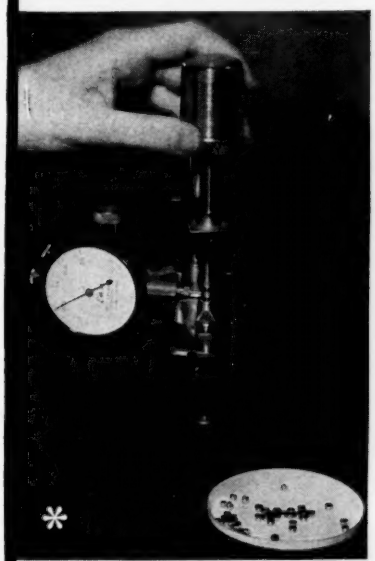

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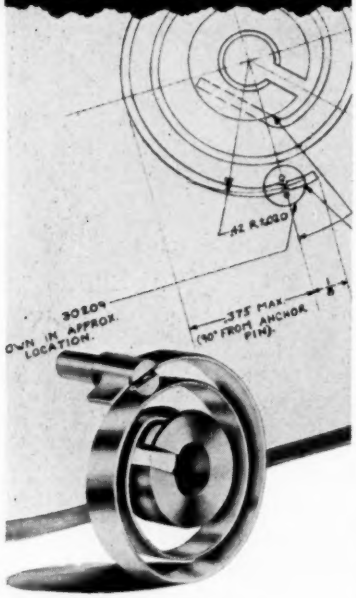

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NEW INSTRUMENTS

Type 300 SS and it physically bonds to other materials with similar expansivities, assuring a helium-leak-tight seal capable of withstanding severe thermal shocks. Its electrical properties are said to be "vastly superior to all present types of glass seals." At high temperature it approximates the properties of high-grade electrical steatite. It is available as preforms, ready for firing by user in fabricating a seal component, or as complete seals.—*Consolidated Electrodynamics Corp.*, 300 *N. Sierra Madre Villa, Pasadena, Calif.*

For more information circle **270** on inquiry card.

DIMENSIONAL GAGING and INSPECTION

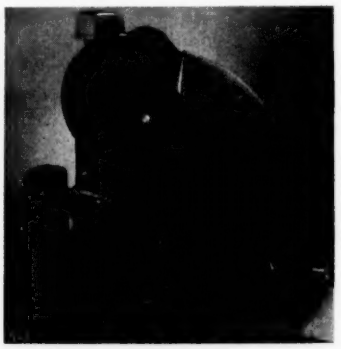
GEAR CHECKER

New Model GRF Red Ring pedestal-type gear gaging, sorting and machine tool control unit for gear production lines can be adapted to check size and helix angle accuracy of spur of helical gears.—*National Broach & Machine Co.*, 5600 *St. Jean Ave., Detroit* 13, *Mich.*

For more information circle **271** on inquiry card.

CONTOUR PROJECTOR

New Model 14-6 features an interchangeable table system comprising a flat staging table for production-line optical gaging (left) and a movable work table (right) for horizontal toolroom measurements. Tables can be purchased separately.—*Optical Gaging Products, Inc.*, 26 *Forbes St., Rochester*, 11, *N. Y.*



For more information circle **273** on inquiry card.

CONTOUR PROJECTOR

New English-made Model WP-100 Universal Projector features exceptional versatility: its regular equipment includes (1) four-lens turret with full adjustments; (2) illumination for both diascopic and episcopic projection by a 1000-w high-pressure mercury-vapor lamp; (3) 60" x 40" clear-glass screen inclined at 11° with vertical straight edges; (4) fine adjustment of magnification to compensate for dimensional changes of materials when present. Optional accessories give it an even wider range of applications.—*Bentley Industrial Corp.*, 41 *E. 42nd St., New York* 17, *N. Y.*

For more information circle **272** on inquiry card.

TOOLMAKER'S PROJECTOR

New Toolmaker's Projector, featuring extreme versatility and extended capacity, utilizes an opaque photometric white 6"x6" screen at rear of hood. Magnified parallax-free images projected onto screen are shielded from extraneous light and reflections. A complete library of screens, each a chart of a specific product or part, is economically justifiable. Innovation: illuminated tolerance lines providing exceptional contast and facilitating accurate measurements. Standard charts of grids, radii, protractor, thread forms, etc., available; special screens drawn or scribed by user. —*Stocker & Yale, Marblehead, Mass.*

For more information circle **274** on inquiry card.

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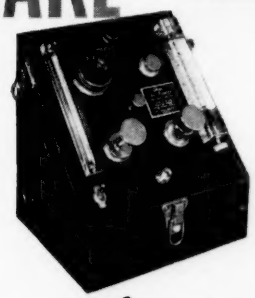

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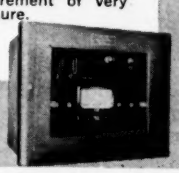

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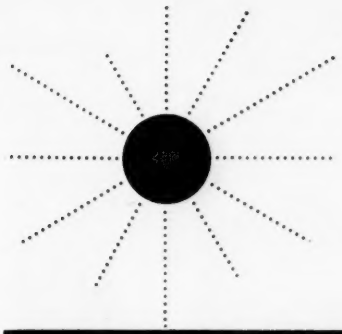

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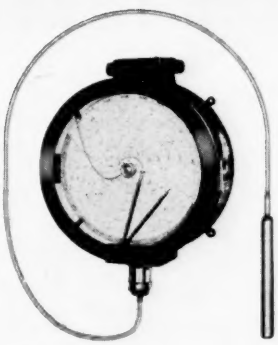

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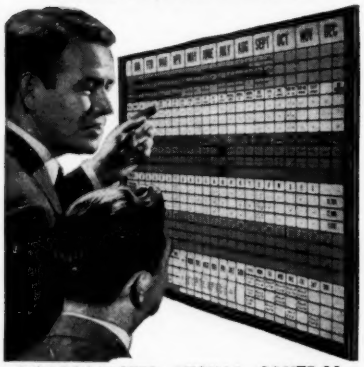

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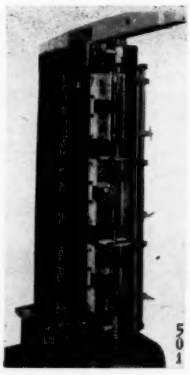


501

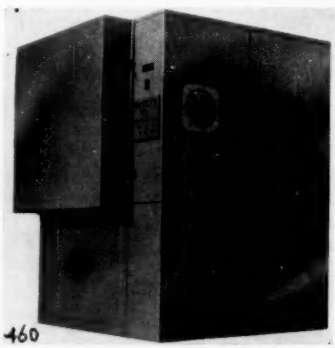
CREEP TESTER

New model of maker's Creep Tester incorporates electric furnaces so arranged that three titanium specimens can be seasoned at one time.—*Riehle Testing Machines Div., American Machine and Metals, Inc., East Moline, Ill.*

For more information circle **275** on inquiry card.

TEMPERATURE CHAMBER

New Model 100/1000 T20 is said to be the first to attain wide range of −100°F to 1000°F. Free work space:



460

24" cube. Instrumentation comprises two recording controllers: one for −100 to 300°F, one for 300 to 1000°F.—*International Radiant Corp., Low Temperature Div., 4 Manhasset Ave., Port Washington, L. I., N. Y.*

For more information circle **276** on inquiry card.

VIBRATION EQUIPMENT

New English-made line of high-powered amplifiers and shakers, designed for vibration and fatigue test-

428

ing, incorporates many special design and operational features. Now available for prompt delivery in US: Models KCD and KLF Power Amplifiers and Model 600 Shaker which withstands continuous operation at 100 G.—*Genisco, Inc., 2233 Federal Ave., Los Angeles 64, Calif.*

For more information circle **277** on inquiry card.

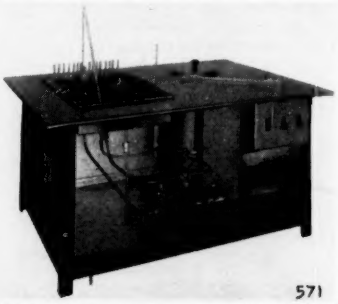
THERMAL CONDUCTIVITY TESTER

New K-Factor Tester measures the specific thermal conductivity of a material; meets ASTM requirements; is said to be quick and convenient to use and low in cost.—*Tatnall Measuring Systems Co.,*

For more information circle **278** on inquiry card.

ELASTOMER TESTER

New modifications are available to equip T-50 State-of-Cure Tester for Temperature Retraction Tests at



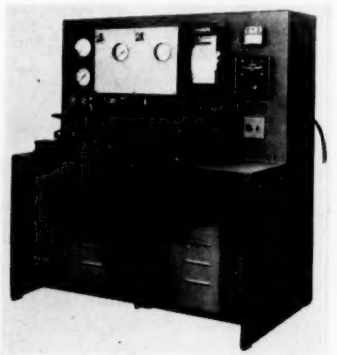
571

−70° in accordance with ASTM D1329-54T (illustrated) and for Brittleness Evaluation at necessary temperatures for compliance with ASTM D746-55T.—*Scott Testers, Inc., 45 Blackstone St., Providence, R. I.*

For more information circle **279** on inquiry card.

DEAD-SPACE MEASURER FOR HYDRAULIC SERVO VALVES

New Hydraulic Servo-Valve Dead-Space Measuring Device measures dead space under actual operating



pressure conditions, yields exact data on edge conditions and location of face of land.—*Hesse-Eastern Div., 136-138 Mt. Auburn St., Cambridge 38, Mass.*

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MARSHALLTOWN

DIAPHRAGM GAUGE

For Accurate Pressure Measurement in Ounces or Inches of Water

Marshalltown Figure 83 is an extremely sensitive gauge that uses a carefully seasoned bronze diaphragm to accurately measure very low pressures. It is used extensively on many types of natural gas installations for checking low pressures.

Write for details and price. LOOK TO MARSHALLTOWN FOR ONE OF THE MOST COMPLETE LINES OF INDICATING PRESSURE GAUGES MADE!

Available in standard dials (reading in inches of water) 0-15" -0-30" -0-60" -0-100" -0-160" . . . also in ounce graduated dials from 15 ounces to 5 pounds. 2½", 3½" and 4½" dial sizes mounted in black enameled steel case.

MARSHALLTOWN MANUFACTURING CO.

MARSHALLTOWN 3, IOWA

For more information circle **86** on inquiry card.

LOOK IT UP in the "GUIDE"!

when you want to know . . .

WHAT instrument-control equipments are available (such as instruments and devices for measurement, inspection, testing, analysis, computing and automatic control, as well as electric and electromechanical components), and

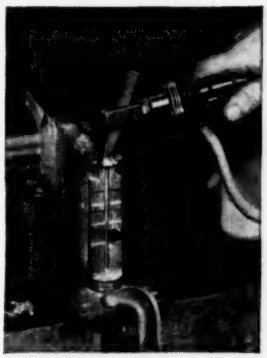
WHO makes them, and

WHERE to purchase them.

The 1958 edition of the *Instruments and Automation Buyers' Guide* was sent to all subscribers in October. If you're not a subscriber, but could use a copy of the only buying directory in the field, then subscribe *now* by circling the number below on the Reader Service card, or use the subscription card in this issue.

For more information circle **1** on inquiry card.

Resistance Heat Soldering Ends "Cold Flow" Rejects-- Insures Strong, Uniform Joints



Resistance heat soldering of parts with preformed soldering rings, using "Pencil" attachment, and jig set-up.

In an increasing number of plants, resistance heat soldering has practically licked the problem of non-uniform solder joints and "solder voids."

The resistance heating principle makes cold flow joints all but impossible. High amperage, low voltage current, passing *through* the joint to be soldered, heats the joint above the temperature required to melt the solder. Heat is concentrated at the point of contact to prevent burning of nearby parts. No set-up or pre-heating is necessary. Solder adheres instantly and uniformly over and between the surfaces to be joined, to make the strongest joint it is possible to make. Heat is adjustable by thumb switch and instantly controlled to meet job requirements.

For the Most Complete Information Available on Resistance Heat Soldering, Send for Data on

IDEAL THERMO-GRIP SOLDERING SETS

Used for more resistance heat soldering than any other type. Complete details on all models, from the 450-watt light duty model up to the 7500-watt unit for large brazing jobs. Also application data on various attachments, including "grip-and-heat" "Pliers", "Fork" and "Pencil" attachments. All units are fully portable.

PROVED BETTER FOR JOBS LIKE THESE:

- Hermetic closures
- Tube joints
- Bellows and diaphragms
- Bourdon tubes
- Wherever strong, vibration-proof or air-tight seals are required.

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GET FULL DATA FREE

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Please send full information and technical data on IDEAL Thermo-Grip Soldering and Brazing Equipment.

Name_____

Company_____

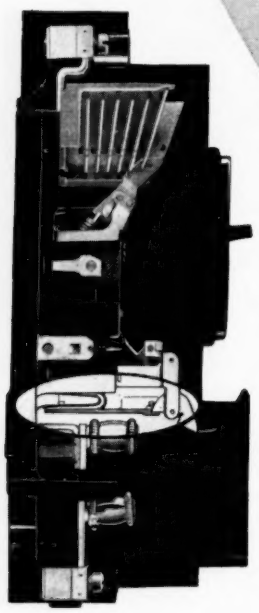
Address_____

City_____ Zone____ State_____

For more information circle **87** on inquiry card.

Chace THERMOSTATIC BIMETAL actuates another precision product

Westinghouse
Tri-Pac
CIRCUIT
BREAKER



A Product of
Westinghouse
Electric Corp.
Standard Control
Division
Beaver, Pa.

The Westinghouse TRI-PAC Circuit Breaker was developed to provide an economical high-interrupting capacity device for protection against short circuits, or fault currents, in applications delivering up to 100,000 amperes to breaker locations. This advanced-type breaker gives *triple* protection - (1) thermal time delay, (2) magnetic instantaneous, and (3) fusible current limiting. Developed by Westinghouse research engineers, this combination is greatly superior to fuses alone. Expensive fuse-replacement is reduced and single-phasing is eliminated.

With a world-wide reputation for reliability of products, it is natural that Westinghouse should rely on Chace to provide the all-important thermostatic bimetal breaker element. Precision-formed to the finest tolerances in the industry, Chace Thermostatic Bimetal is rigidly tested and inspected by experts with over a third of a century of exclusive bimetal specialization. With unerring and automatic precision, these vital elements initiate the breaking of the circuit when fault currents endanger valuable equipment. *Made* better to help industry's products *perform* better, Chace Thermostatic Bimetal continues to widen its usage in applications everywhere, year after year.

Remember Chace when you design for protection of valuable equipment or for temperature actuation or indication. Dependable Chace Thermostatic Bimetal is available in 28 types, in strip, coil, or completely fabricated and assembled elements made to your specification. (We do not manufacture complete controls or any other devices in competition with our customers.) Write today for new 44-page booklet, "Successful Applications of Chace Thermostatic Bimetal", containing interesting uses of bimetal and many pages of engineering data that may help you solve your product problems.

IT BENDS WITH THE HEAT

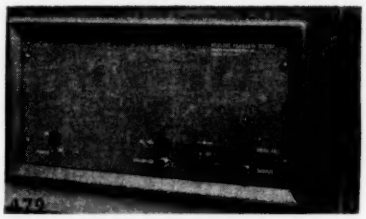
W. M. CHACE CO.
Thermostatic Bimetal
1609 BEARD AVE., DETROIT 9, MICH.

For more information circle **88** on inquiry card.

ELECTRICAL TESTING

DIODE TESTER

New Diode Recovery Tester is an extensive modification of a circuit developed by the NBS; is said to have

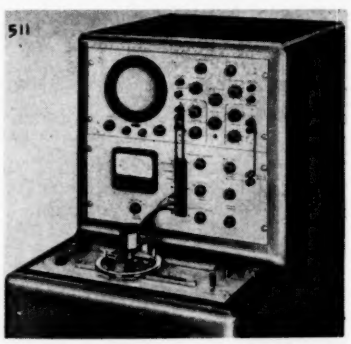


"a degree of accuracy never before achieved in measuring diode recovery characteristics in the 0.05 to 0.3 usec range."—*Pacific Semiconductors, Inc.*, 10451 *W. Jefferson Blvd., Culver City, Calif.*

For more information circle **281** on inquiry card.

LINEARITY TESTER

New TP-800 Linearity Tester enables quantity users of precision voltage-dividing resistors to check

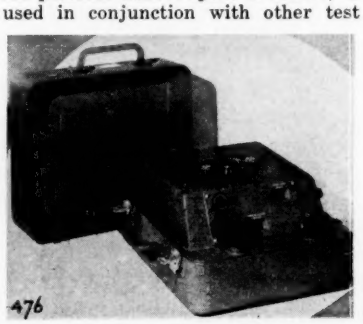


them for linear accuracy; obviates need of time-consuming and expensive manual methods; reduces test time from hours to minutes with improvement in accuracy.—*Technical Products Co.*, 6670 *Lexington Ave., Los Angeles* 38, *Calif.*

For more information circle **282** on inquiry card.

SYNCHRO INDEX STAND

New Part Number KT 426077 holds and accurately locates rotor shaft of a synchro to a desired angular position with respect to stator; is used in conjunction with other test



Petrometer

SERIES 1400

LIQUID DEPTH GAUGES

ACCURATE and EASY TO INSTALL

Available in 4 Models, Petrometer Series 1400 Tank Gauges operate on the sound principle of hydrostatic pressure. No moving parts, no expensive electrical or electronic equipment. Large vertical scale gives accurate, easy-to-see reading. And construction features make installation easy.

For complete information send for Bulletin 6004

Petrometer
CORPORATION

43-22 TENTH ST., LONG ISLAND CITY 1, N. Y.

For more information circle **89** on inquiry card.

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Quantity production of standard and special coatings to your exact specifications

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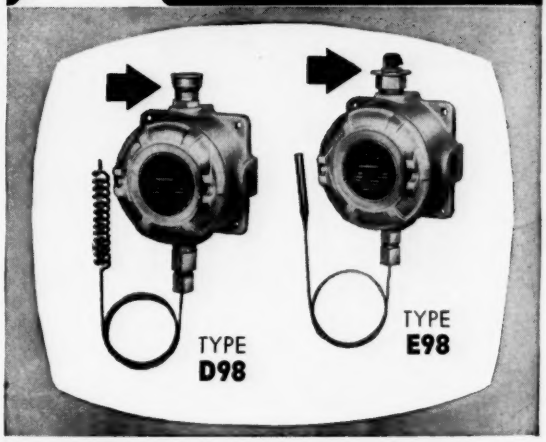
SANTA ROSA, CALIFORNIA

For more information circle **90** on inquiry card.

EXPLOSION PROOF D98 | E98 TEMPERATURE CONTROLS



UNITED ELECTRIC has designed the D98 and E98 units to automatically and sensitively control the temperatures of gases, liquids and hot plate applications where explosive vapors and gases are present. Both units feature external, calibrated temperature adjustments. The E98 adjustments are made by a single-turn adjustment knob and pointer, while the D98 has a multiple-turn, micrometer type adjustment.

Temperature Ranges	Type D98 — 300° or 550° F between limits of −150° and +650° F. Type E98 — 100° or 200° F between limits of −150° and +650° F.
Thermal Assemblies	Various shapes and sizes of thermal assemblies available. Completely liquid-filled bellows, bulb and capillary assembly.
Switch Ratings	15 amps. at 115 or 230 volts AC, also 20 amps. or DC switches on specification.
Switch Types	N.O., N.C., or Double Throw, no neutral position.
Electrical Connections	Two, ¾" NPT conduit openings in enclosure. Internally-located terminal block.
Size & Weight	9¼" x 5¾" x 3⅞" — weighs approx. 8 lbs. 4 oz.
Enclosure	Class I, group D and Class II, groups E, F and G explosion-proof enclosures; cast iron base, aluminum cover.
ON-OFF Switch Differential	Fixed, uniform throughout specified range.
Mounting	Surface mounted in any position by mounting holes in each corner of base.

UNITED ELECTRIC *manufactures a complete line of temperature, pressure, and vacuum controls. UE will gladly modify or custom-build a unit to meet your specifications. Consult a UE application engineer today.*

Write for Bulletin No. 3-1 for complete D98 data or Bulletin No. 3-5 for complete E98 data.

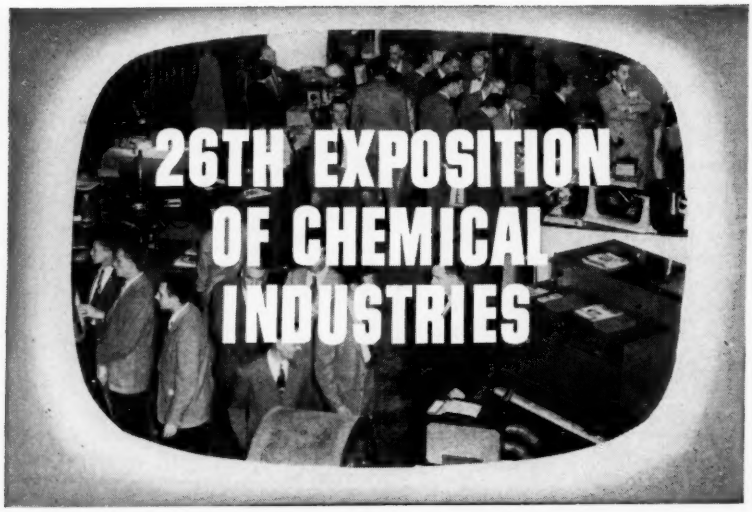
U.E.

United Electric Controls
COMPANY

81 SCHOOL STREET WATERTOWN MASS.

For more information circle **91** on inquiry card.

Tune in on *What's New* at the



NEW YORK COLISEUM
Dec. 2-6, 1957

Four full floors of fact-filled exhibits—over 500 displays dramatizing the latest developments in the industry . . . all under one roof . . . new methods . . . new ways to cut costs. They reflect the results of the constant search for new processes, more efficient techniques and improved performance.

Make your plans now to attend with your executives, engineers, designers and chemists. You will find hundreds of new ideas in the latest developments for the chemical industries—processing equipment, materials handling and packaging, laboratory apparatus, chemicals and raw materials, controls and instruments, etc.

For your convenience, new sections have been established for displays of laboratory apparatus and supplies, chemicals and raw materials. This grouping of specific exhibits will save time in securing new and helpful information.

DON'T MISS the greatest concentration of new and important developments ever assembled in one convenient location. You will come away with valuable and profitable new ideas.

Reserve Time and Place Now on Your Calendar.

New York Coliseum • December 2-6, 1957

26th EXPOSITION OF CHEMICAL INDUSTRIES

***Management* International Exposition Company**

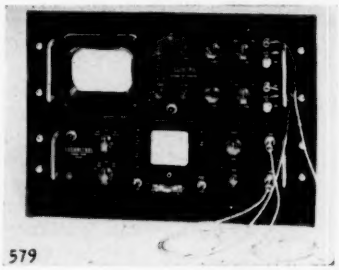
For more information circle **92** on inquiry card.

equipment to determine electrical error, transformation ratio, perpendicularity, and fundamental and rms null voltages.—*Kearfott Co., Inc.*, 1378 *Main Ave., Clifton, N. J.*

For more information circle **283** on inquiry card.

DIODE TESTER

Two new companion instruments: (1) Dynamic Diode Tester quickly checks all common types of semicon-



ductor diodes for irregularities by means of dynamic curve projected on a calibrated 'scope screen. (2) Cathode Ray Indicator provides the indicating screen; matches tester; is stable. Circuitry is designed for minimum noise and hum; provides instantaneous quantitative measurements.—*Technitrol Engineering Co.*, 1952 *E. Allegheny Ave., Philadelphia 34, Pa.*

For more information circle **284** on inquiry card.

MOTOR TESTING AND RUN-IN MACHINE

New "Lectrotest" for automatic running-in and checking of electric motors provides a 15-min run-in peri-

od for about 1000 motors per hour at a stabilized power input; then tests for grounds, open circuits and shorts at high and low speeds, and automatically shuts off motors which prove defective; can be modified to check generators, regulators, etc.—*Michigan Production Engineering Co.*, 1796 *E. Nine Mile Rd., Hazel Park, Mich.*

For more information circle **285** on inquiry card.

DIFFERENTIAL SWITCH

senses pressure differences from .45 to 45 inches of water

Used in hopper level indicating, on oil burner blower safety control, in instrumentation or similar applications where it is necessary to sense a pressure difference of .45 to 45 inches of water between a variable and a reference pressure. The reference pressure may be as high as 30 P.S.I.

WE BUILD IN	WE DON'T USE
EXTREME ACCURACY and DEPENDABILITY maintained during operating life due to direct acting design	**LINKAGES & BEARINGS** which as they wear, make the setting of the pressure switch drift.
OPERATION IN ANY POSITION which saves the installation costs encountered in mounting a switch that uses liquid switching elements.	**LIQUID SWITCHING ELEMENTS** which make the switch difficult to mount and very critical to vibration.
IMMUNITY TO VIBRATION you can mount the switch directly on your vibrating or moving equipment.	**ACCORDION DIAPHRAGMS** which make the pressure switch sensitive to vibration.

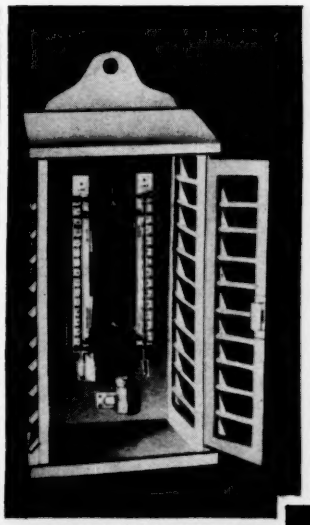
Ask for bulletin 227

BARKSDALE VALVES

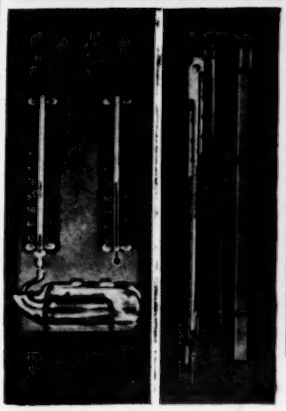
PRESSURE SWITCH DIVISION

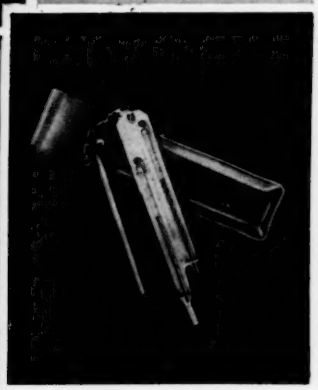
5125 Alcoa Avenue, Los Angeles 58, California

For more information circle **93** on inquiry card.



You get **dependability PLUS** with Moeller psychrometers





because designing and manufacturing temperature measuring instruments and psychrometers has been our business since 1867.

Nothing's as changeable as the weather and the atmosphere unless it's the reading indicated on Moeller Psychrometers. For almost 90 years—whether indoors or out—Moeller Psychrometers have proven accurate, regardless of climatic conditions.

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For more information circle **94** on inquiry card.

ANNOUNCING...

An Important Improvement in INDUSTRIAL TELEVISION

DIAMOND "UtiliVue" MODEL 500 CAMERA SYSTEM

This new industrial television camera and control unit provide a sharper picture with finer detail. The 500 has automatic compensation for wide variations in light on the scene viewed . . . assuring a good picture with any reasonable illumination. Picture quality is maintained automatically under wide fluctuations in line voltage.

The miniaturized camera is exceptionally compact and easy to use. The controls are simple and can be remotely located from the camera. As many as five cameras can be used with one control unit by means of a Diamond camera switcher.

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For more information circle **95** on inquiry card.

SWEEPING OSCILLATOR

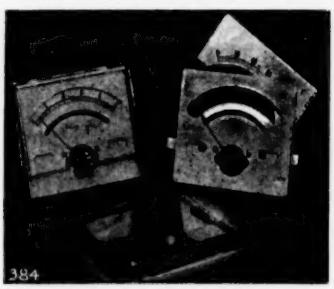
New Model 207A *RC*-type audio sweep oscillator features 20-cps to 20-kc range in a single dial sweep without bandswitching and with greater stability than other audio sweeping types; has been designed for motor drive to speed testing of audio circuits, etc.—*Hewlett-Packard Co., 275 Page Mill Road, Palo Alto, Calif.*

For more information circle **286** on inquiry card.

ELECTRICAL and ELECTRONIC INSTRUMENTS

CUSTOM INSTRUMENTS

New 2½", 3½", and 4½" rectangular instruments feature interchangeable scale faces, shunting and multi-

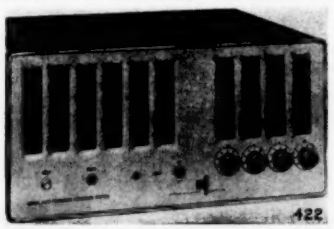


plier resistors which will permit coverage of more than 100 voltage and current ac and dc ranges; also fatigue-tested springs; 2% accuracy; knife-edged pointer and mirror scale; optional illumination and shadow mask.—*Precise Development Corp., Oceanside, N. Y.*

For more information circle **287** on inquiry card.

FREQUENCY DEVIATION METER

New Model 6005 Frequency Deviation Meter permits rapid direct read-out of the deviation of a fre-



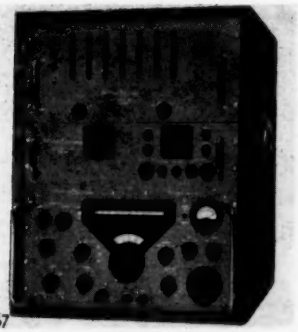
quency from 1 to 10,000 cps in parts per million ±1 count; comprises a preset counter section, gating and controlling circuits, a temperature-

regulated crystal-controlled 1-Mc oscillator and display section. Operation is simple.—*Computer-Measurement Corp., 5528 Vineland Ave., N. Hollywood, Calif.*

For more information circle **288** on inquiry card.

FREQUENCY MONITOR FOR RADIATED SIGNALS

New Model 7700 Sensitive Frequency Measuring System, said to "make measurements 100 times faster

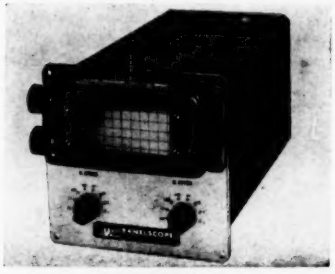


than other methods," measures virtually all types of radiated signals in 0.54 to 30.5 Mc range; is accurate to 1 part in 10^7; combines a high-speed electronic counter and a quality communications receiver. Tuning receiver to desired frequency yields a direct digital reading on counting unit.—*Beckman Berkeley Div., 2200 Wright Ave., Richmond 3, Calif.*

For more information circle **289** on inquiry card.

PHASE MEASUREMENT 'SCOPE

New Model PIA5X5 Panelscope has been specifically designed for oscilloscope type phase measurements and

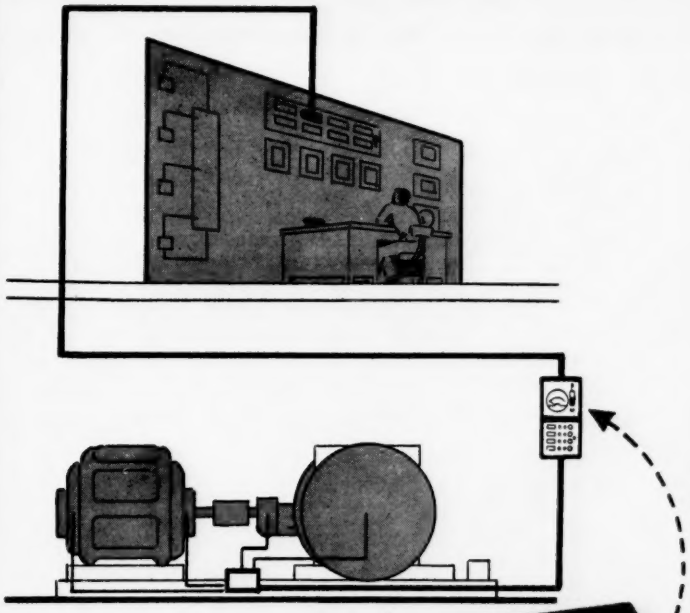


observation of other Lissajous patterns. Vertical and horizontal amplifiers differ only in basic sensitivity; each has a 7-position attenuator switch. Phase shift is zero for any attenuator position between 40 and 2000 kc.—*Waterman Products, Inc., 2445-63 Emerald St., Phila. 25, Pa.*

For more information circle **290** on inquiry card.

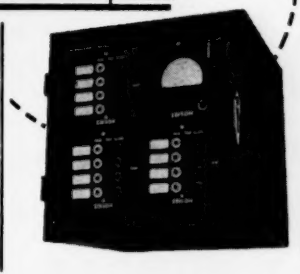
TRANSISTORIZED FREQUENCY METER

New Model FM-241, added to maker's line of modular instruments, measures frequencies from 10 cps to 100 kc with 2% accuracy regardless of wave shape down to a 1%



EDISON OMNIGUARD

REMOTE TEMPERATURE MONITOR



assures continuous protection at lowest cost

Wherever critical temperatures need constant watching . . . bearings, liquids, gases . . . OMNIGUARD indicating and alarm systems can save hundreds of man-hours, with greater accuracy and dependability than human checking could possibly render . . . and at a lower cost than any other system.

Omniguard watches temperatures continuously at distant, dangerous and often inaccessible points, eliminates human errors, makes possible longer and higher peak loads because warning is given before danger levels are reached. Note these outstanding advantages:

- **Low equipment cost** . . . you buy only the points you need . . . modular plug-in units can be added any time.
- **50% lower installation costs.**
- **One indicator serves multiple points.**
- **Each circuit independent of all others.**
- **Absolute dependability** . . . no moving parts . . . no electronic circuits . . . no maintenance.
- **No personnel training required** . . . it's completely automatic.

Write for literature and specifications.

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INDUSTRIES
INSTRUMENT DIVISION
24 LAKESIDE AVENUE
WEST ORANGE, NEW JERSEY

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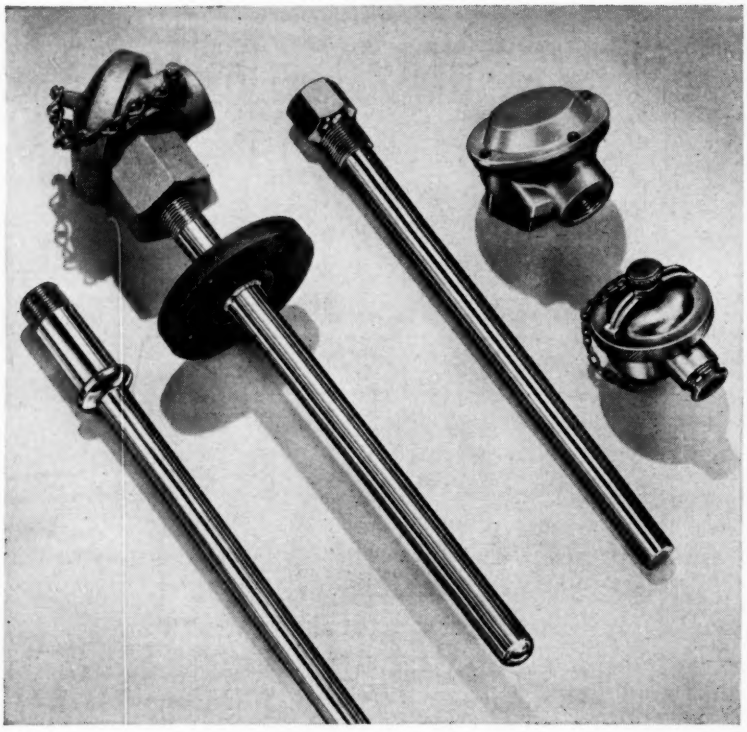

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THERMOCOUPLE ASSEMBLIES

At Thermo Electric you'll find everything for your temperature measuring needs—sensing elements, instruments and accessories. T-E's thermocouples are a good example. There's one for *every* application, *every* operating condition. And each T-E thermocouple is manufactured under close control to exacting standards. They're available in Iron-Constantan, Copper-Constantan, Chromel-Alumel and Platinum-Rhodium-Platinum.

Heavy Duty Thermocouples—wire and tubular—provide the rugged construction needed for severe conditions, while retaining sensitive performance.

Protection Tubes (Thermo-Wells)—bar stock or built-up, straight or tapered, with threaded, flanged or ground-joint mountings—are available in all commercial materials for all applications.

Miniature Thermocouples are made in a wide variety of types and sizes for any installation requiring a small-size yet sensitive assembly.

Accessories include a complete selection of connection heads, fittings, terminals, quick-coupling connectors and extension wires.

***Thermo Electric* Co., Inc.**

SADDLE BROOK, NEW JERSEY

In Canada — THERMO ELECTRIC (Canada) Ltd., Brampton, Ontario

For more information circle **97** on inquiry card.

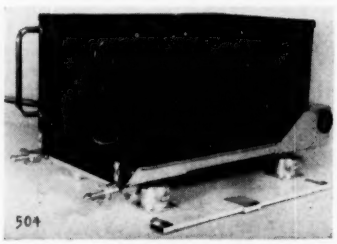
NEW INSTRUMENTS

duty cycle. Seven full volt ranges from 100 cps to 100 ks. Minimum input voltage 0.1; maximum 120.—*Teletronics Lab., Inc.*, 54 *Kinkel St., Westbury L. I., N. Y.*

For more information circle **291** on inquiry card.

FREQUENCY STANDARD

New O-(XA-31)/U airborne frequency standard, first of its kind, is used to calibrate all airborne elec-

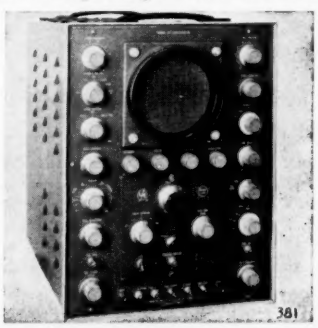


tronic equipment that depends upon frequency accuracy. Its output is a 100-kc signal.—*The G. W. Borg Corp.*, 120 *Main St., Janesville, Wis.*

For more information circle **292** on inquiry card.

OSCILLOSCOPE

New Model 411A features smooth automatic trigger synchronization by vertical input signal over the whole

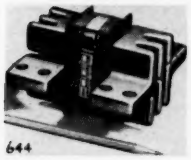


pass band from less than 10 cps to more than 10 Mc. Synchronization, easily attained by use of a single control, is independent of positioning or amplitude adjustments. Diversification is obtained through use of several plug-in units.—*Laboratory for Electronics, Inc.*, 75 *Pitts St., Boston* 14, *Mass.*

For more information circle **293** on inquiry card.

ELECTR-INSTRUMENT ACCESSORIES

PARALLELING REACTOR



New PR 1600 is rated at 1600 amp rms for a 50 C° temp rise with normal convection cooling (with forced-air cooling, rating can be increased to 2200 amp rms). It functions as does a current transformer with a 1-to-1 ratio, forcing equality of current in its windings, even if connected to two junctions of different forward voltage drop. Thus it can assure equal voltage distribution in paralleling bridge-type circuits multiple groups in parallel, or multiple strings in series.—*International Rectifier Corp., El Segundo, Calif.*

For more information circle **294** on inquiry card.

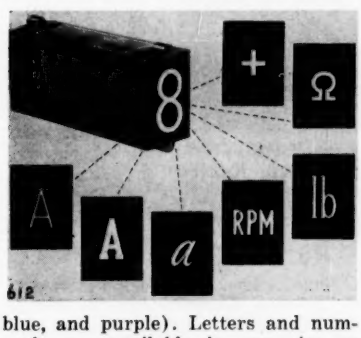
DIRECT-READING TEN-TURN DIAL

New direct-reading ten-turn dial features unique advantages that tenths of each turn are indicated directly in numerals (eliminating readout error) and that each tenth of a turn is accurately subdivided in ten parts, whence total of 1,000 divisions for ten turns of knob. Drive ratio is 1-to-1 with CCW rotation increasing reading. Dial mounts in a single hole and accepts any ¼" shaft.—*Johanson Mfg. Corp., Boonton, N. J.*

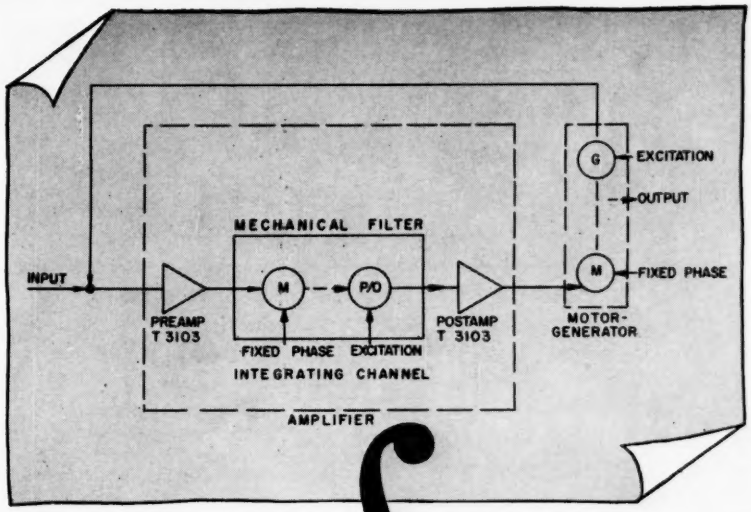
For more information circle **295** on inquiry card.

IN-LINE DIGITAL DISPLAY

New model of In-Line Display features digits of various sizes, shapes, colors (available: red, green, yellow, blue, and purple). Letters and numerals are available in any size or typographic family, including foreign characters, etc.—*Industrial Electronic Engineers, 3973 Lankershim Blvd., North Hollywood, Calif.*



For more information circle **296** on inquiry card.



This diagram illustrates an optimum configuration of a precise integrating servo system. The essential components are shown below.

$$\int (f)\,dt$$

SERVO MOTOR GENERATOR

This size 15 unit represents the latest in design for precise integrating tachometers. Temperature stabilized to within 1° C; linearity, 0-3600 R.P.M., .03% of 3600 R.P.M., 0-4800 R.P.M., .05% of 3600 R.P.M.

MECHANICAL FILTER

This size 11 filter, used in conjunction with amplifiers shown, provides an integral-plus-proportional circuit. Eliminates quadrature and noise in the error signal and the need for high gain, critical amplifiers.

TRANSISTORIZED AMPLIFIERS

This T3103 amplifier provides a 40 v., 6 w. output. Meets the requirements of MIL-E-5400. Dimensions 1⅝" x 1⅝" x 1⅞" high, weight 4.7 oz.

The above units are available as components for your specific applications or as packaged sub-assemblies.

KEARFOTT COMPONENTS INCLUDE:

Gyros, Servo Motors, Synchros, Servo and Magnetic Amplifiers, Tachometer Generators, Hermetic Rotary Seals, Indicators and other Electrical and Mechanical Components.

KEARFOTT SYSTEMS INCLUDE:

Directional Gyro Compass Systems, Three Gyro Stable Platform Systems and Inertial Navigational Systems.

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For more information circle **98** on inquiry card.

THE FAMILY OF Waterman POCKETSCOPES

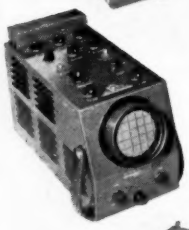
Portable—Dependable—Economical

Rugged, highly portable "pocket-size" oscilloscopes that can be carried to the job in one hand without sacrifice of the high precision that qualifies them for laboratory use. For field, production line, or laboratory, they save labor, space, money! POCKETSCOPES combine high electrical performance, reliability and low cost.

S-11-A INDUSTRIAL POCKETSCOPE

Features DC amplifier, repetitive sweeps and circuit ground isolation . . . for DC and low frequency work.

5" x 7" x 11" . . . 8¾ lbs. **$149.50**



S-14-A HI-GAIN POCKETSCOPE

Identical vertical and horizontal amplifiers, sensitivity to 10 mv; trigger or repetitive sweeps from ½ cps. to 50 KC; ± sync; calibrated voltages.

6" x 7" x 12" . . . 12¾ lbs. **$249.00**

S-14-B WIDE BAND POCKETSCOPE

Similar to S-14-A except lower sensitivity, greater bandwidth. Triggered or repetitive sweeps from ½ cps to 50 KC;

6" x 7" x 12" . . . 14 lbs. **$239.00**

S-14-C COMPUTER POCKETSCOPE

DC type signal amplifier bandpass more than meets need of most computer service... calibrated trigger sweeps; 5X trace expansion; excellent stability.

6" x 7" x 12" . . . 16 lbs. **$289.00**

S-15-A TWIN-TUBE POCKETSCOPE

A unique approach to dual trace oscilloscopy . . . two rectangular cathode ray tubes, common internal trigger or repetitive sweep generator . . . DC type signal amplifiers sensitivity to 10 mv.

6" x 7" x 12" . . . 16¼ lbs. **$399.00**

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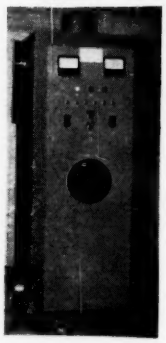
For more information circle **99** on inquiry card.

POWER SUPPLIES

10-KV 1-AMP DC SUPPLY



New Model PC-58 produces 0-10 kv at 0-1 amp dc with 1% rms ripple; either positive or negative polarity with opposite side grounded; is completely monitored and protected; can be interlocked with other equipment; requires about 15 kva from 230-v 3-phase 60-cps source.—*Levinthal Electronic Products, Inc., 726 Stanford Industrial Park, Palo Alto, Calif.*

For more information circle **297** on inquiry card.

125-vdc POWER SUPPLY

New Model GFA, said to provide "higher efficiency by the use of germanium rectifiers," operates on 125-

526

v 50/60 cps, delivers continuously variable 0-125 vdc up to 10 amp with less than 1% ripple at top load. —*Electro Products Labs., 4500 N. Ravenswood Ave., Chicago 40, Ill.*

For more information circle **298** on inquiry card.

MISSILE TEST SUPPLIES

560

New M-675, M-676, M-677 and M-678 semi-militarized dc power supply units are especially designed for missile test, checkout and actual launching of the Thor, Atlas, Earth Satellite and Bomarc missiles.—*Perkin Engineering Corp., 345 Kansas St., El Segundo, Calif.*

For more information circle **299** on inquiry card.

TWO PHASE POWER SUPPLY

New 2-phase power supply, said to be unique, fills growing need in development and testing of servos, torquers, and other 400-cps components. All outputs are continuously variable, whence extreme flexibility. Two in-phase outputs allow separate excitation of pick-offs, tachometers or motor reference phases for system

development. Total power output is over 500 va.—*Pacific Technical Co., 2047 Sawtelle Blvd., Los Angeles 25, Calif.*

For more information circle **300** on inquiry card.

DC POWER SUPPLY

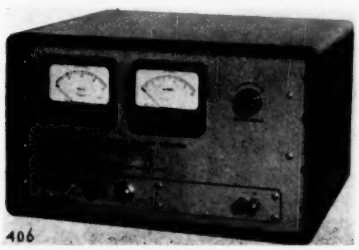
New Model NFB Universal specially-filtered dc power supply features less than ¾% ripple at top load. Voltages from 0 to 32 with current

loads from 0 to 15 amp on 115-v 50/60-cps input.—*Electro Products Labs., 4500 N. Ravenswood Ave., Chicago 40, Ill.*

For more information circle **301** on inquiry card.

TUBELESS 1-KW DC SUPPLIES

New transistorized regulated dc power supplies deliver voltages from 3 to 350 and currents from 50 ma to



20 amp; feature combination of mag amp pre-regulators and unique transistor circuitry as final element of regulation, resulting in a performance said to equal or excel vacuum-tube type or straight mag-amp type power supplies.—*Perkin Engineering Corp., 345 Kansas St., El Segundo, Calif.*

For more information circle **302** on inquiry card.

RECTIFIERS

SILICON RECTIFIERS

New line of 16 silicon rectifiers is characterized by high voltage ratings and excellent efficiency at high temperatures; is divided into two

AT LAST!

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- The units will provide effluent dewpoints of —100° F. to —140° F. continuously, regardless of even major fluctuations in the temperature of the gas or air.
- Installation costs reduced.
- Maintenance costs reduced.
- Effluent air or gas temperatures remain constant.
- Steam or electric heaters are not required, eliminating KW and steam consumption.
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For more information circle **100** on inquiry card.

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RESISTANCE METER

DIRECT READING FROM 0 OHMS TO 10,000,000 MEGOHMS

- 3 TEST VOLTAGES: 1½, 50, 500 VOLTS
- ACCURATE WITHIN 3% TO 1,000,000 MEGOHMS
- PRE-SETTABLE "CHARGE ADJUST" CONTROL FOR RAPID GO, NO-GO CAPACITOR CHECKING

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For more information circle **101** on inquiry card.

NEW INSTRUMENTS

groups: (1) PS100 series of 8 miniature silicon rectifiers rated at 200 ma maximum average forward current; max rms voltage input from 35 to 280 and temperature rating 150°C; (2) PS005 series of 8 subminiature silicon rectifiers rated at 125 ma, max rms voltage input from 35 to 280 and 100°C.—*Pacific Semiconductors, Inc.*, 10451 *W. Jefferson Blvd., Culver City, Calif.*

For more information circle **303** on inquiry card.

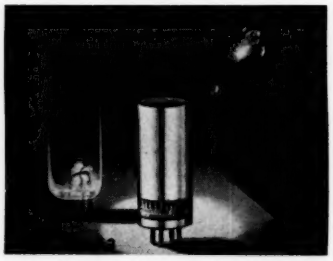
SWITCH RECTIFIER

New unit rectifies 115-v 60-cps ac to operate any of maker's 115-vdc stepping switches; will operate either a single switch or a group of switches, one at a time. Within its ratings, it can also be used to operate a relay or a group of relays.—*C. P. Clare & Co.* 3101 *Pratt Blvd. Chicago* 45, *Ill.*

For more information circle **304** on inquiry card.

TUBE-BASE-MOUNTED SILICON RECTIFIERS

New tube-base-mounted silicon replacements for vacuum tube rectifiers provide savings on filament

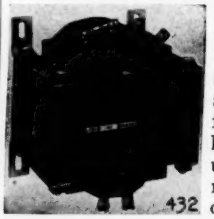


power supply, cooler operation, long life, and resistance to vibration and shock.—*International Rectifier Corp., El Segundo, Calif.*

For more information circle **305** on inquiry card.

ELECTRICAL COMPONENTS

CONTROL TRANSFORMERS



New Type SZO control circuit transformers, available in standard sizes from 0.05 to 5 kva, can handle up to 1000% inrush current with only 5% voltage

drop below rated capacity. Weight- and space-saving design features, plus interleaved windings, bring savings in initial cost, weight, and panel space.—*Hevi-Duty Electric Co., Milwaukee 1, Wisconsin.*

For more information circle **306** on inquiry card.

TRIMMING VDR

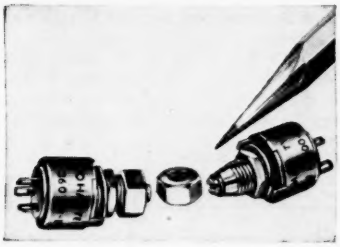
New tiny "Padohm" precision voltage-dividing resistor for pad or trim resistance functions is screwdriver-adjusted, is available in resistance

values from 100 to 20,000 ohms, and standard over-all resistance tolerances of plus or minus 10% with 2% standard linearity. Type L rated at 0.25 watt, derated to 0 power at 105°C; Type H, 0.40 watt, derated to 0 power at 135°C.—*Clarostat Mfg. Co., Inc., Dover, New Hampshire.*

For more information circle **307** on inquiry card.

COMPOSITION VDR

New Type AS Miniature Potentiometer, smallest molded composition voltage-dividing resistor available



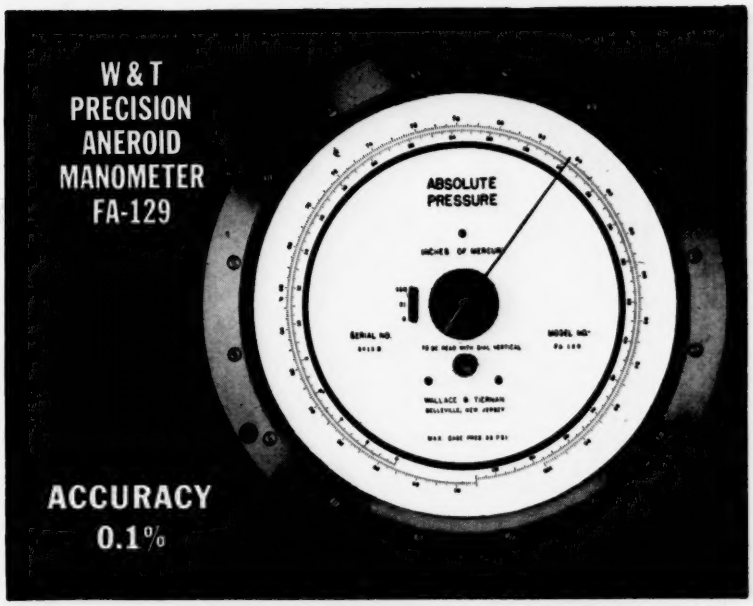
(½" diam), is rated at 0.5 watt continuous duty; dust-tight and fungus resistant; available in 15 resistance values from 100 ohms to 5.0 megohms; meet MIL specs.—*Ohmite Mfg. Co., 3630 Howard St., Skokie, Ill.*

For more information circle **308** on inquiry card.

ELECTRONIC COMPONENTS

TRANSISTORS

Two new sealed transistors of germanium *p-n-p* type: 2N398 is an alloy junction type designed for direct operation of high-voltage on-off control devices; 2N384 is a drift transistor for use as an oscillator up to 250 Mc, as an RF amplifier in mobile



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Ranges:	0 to 31.5 inches of Hg. absolute (min.) 0 to 100 inches of Hg. absolute (max.) Other intermediate ranges available
Accuracy:	1/1000 of full scale
Sensitivity:	1/10,000 in *all* ranges
Scale Length:	45 inches in two revolutions
Dial Size:	8½ inch diameter

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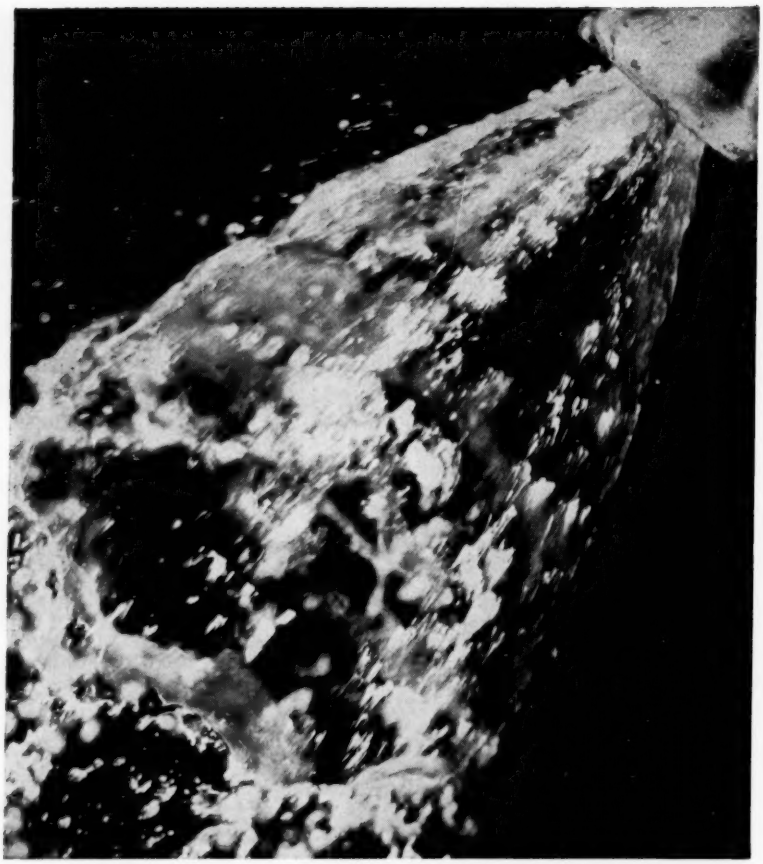

To show fluid volume, photographer Bernard Hoffman uses the free discharge of water from an ordinary garden hose.

Controlling Volume in Fluid Engineering

Few volume control problems can be solved with a quick twist of your wrist the way you do with a garden hose nozzle. In processing equipment, the factors of pressure, flow, and time must also be carefully considered. That's why, when you need accurate answers, you can depend on the broad engineering background S. Morgan Smith offers.

Take an SMS Rotovalve, for instance. Its full line opening means least head loss, lower pumping costs. Hydraulic imbalance and mechanical design make the Rotovalve easy to operate. Fast initial shut-off limits reversal of flow, and closing can be in one second or as slow as required. Final closure is positive and drop tight throughout valve life. SMS Ball Valves, similar to Rotovalves, offer many of these same advantages.

Information on the complete SMS line – R-S Butterfly Valves, Rotovalves and Ball Valves may be obtained by calling our nearest representative. Or, write S. Morgan Smith Co., York, Pa., for data on standard valves or special, engineered applications.

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For more information circle **103** on inquiry card.

communications equipment, as an IF and low-level video amplifier, and as a pulse amplifier and high-speed switching device in electronic computers.—*Radio Corp. of America, 30 Rockefeller Plaza, New York 20, N. Y.*

For more information circle **309** on inquiry card.

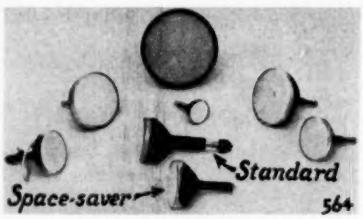
TRANSISTORS

Twelve new *p-n-p* germanium transistors in JETEC-30 standardized package: Four types are especially for computer use and have alpha frequency cutoff values of 4, 6, 11 and 17 Mc respectively; two types are for special-purpose RF applications and have alpha frequency cutoff values of 10 and 20 Mc respectively. Six new types are for portable radio receiver circuits.—*Raytheon Mfg. Co., 55 Chapel St., Newton 58, Mass.*

For more information circle **310** on inquiry card.

RADAR TUBES

New line or radar tubes which reduce space requirements by as much as 6" (over-all length) for airborne



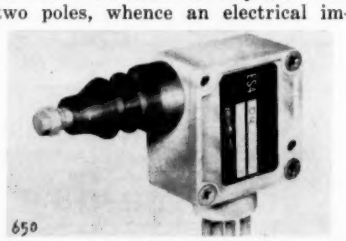
installations includes electrostatic and magnetic focus tube-types from 3" to 10" dia.—*Allen B. Du Mont Labs., Inc., 750 Bloomfield Ave., Clifton, N. J.*

For more information circle **311** on inquiry card.

SWITCHES & RELAYS

DP DT SWITCH

New ES4-DM3 die-cast switch provides simultaneous one-way action on two poles, whence an electrical im-

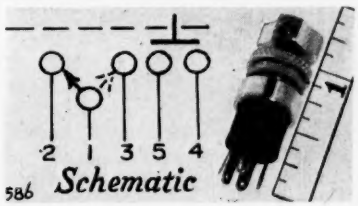


pulse on inward stroke without operating switch on return to its normal position. It eliminates complicated one-way dogs, extra switches, and costly relays. Rated 15 amp 125/250 vac, 30 vdc.—*Electro Snap Switch & Mfg., Co., 4218 W. Lake St., Chicago 24, Ill.*

For more information circle **312** on inquiry card.

MINIATURE DUAL SWITCH

New 2-in-1 miniature switch achieves dual switching feature by cap depression and cap rotation: (1)



Pressure on cap closes isolated switch; release of pressure returns switch to n-o position without affecting other switch circuit; (2) second switch is sp-dt unit actuated by cap rotation. —*Marco Industries Co.*, 207 *So. Helena St., Anaheim, Calif.*

For more information circle **313** on inquiry card.

OVER-VOLTAGE RELAY

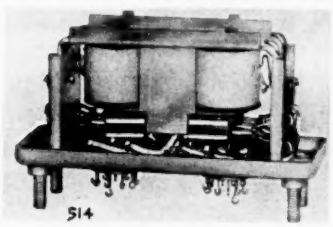
461

New Model TD-812A over-voltage relay for multiple generator systems and for high-speed high-altitude aircraft, is completely hermetically sealed; is insensitive to 10-G vibrations up to 500 cps; has a selector winding to detect generator that has gone over-voltage.—*Hartman Electrical Mfg. Co.*, 175 *N. Diamond, Mansfield, Ohio.*

For more information circle **314** on inquiry card.

6P-DT LATCHING RELAY

New KG 6p-dt magnetic latching relay employs a permanent magnet to hold armature securely in either posi-


514

tion; remains operative during 100-*G* shock, with contacts opening for no more than 80 microseconds; withstands vibrations of 30 *G* acceleration from 55 to 2000 cps. Contact loads to 5 amp 28 vdc resistive and 3 amp 115 vac resistive.—*Potter & Brumfield, Inc., Princeton, Ind.*

For more information circle **315** on inquiry card.

SHOCK-RESISTANT RELAY

New 10-microampere ruggedized and sealed magnetic-contact relay withstands more than 500 *G* and vibration of 5 to 55 cps at 0.06" amplitude. Either ac or dc can be pulled

MODEL "M" SERIES

Marksman tubeless electronic potentiometer strip chart RECORDER for recording and controlling such variables as temperature, speed, strain, pH and many others.

- No vacuum tubes. Sensitivity of 5 micro-volts or less.
- Potentiometer for thermocouple (TCB protected) or radiation pickup, Wheatstone bridge for resistance pickup.
- Full selection of standard scale ranges . . . 11" calibrated chart width.
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- Equipped for 115 or 230 volts — no transformers needed.
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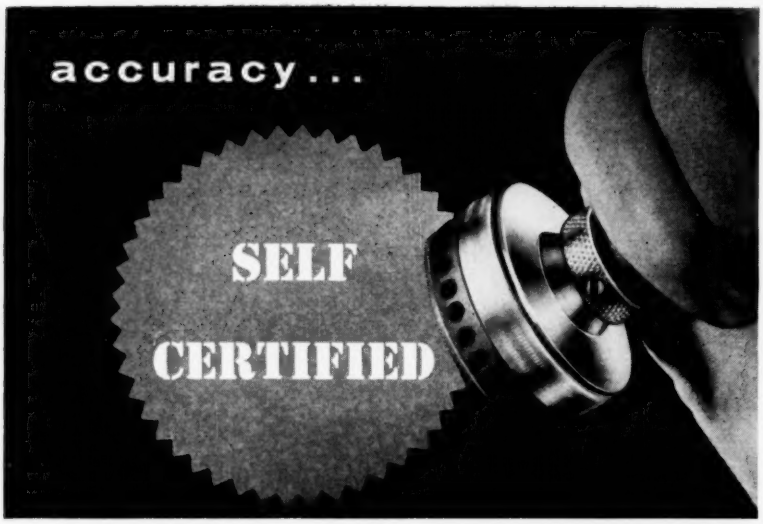

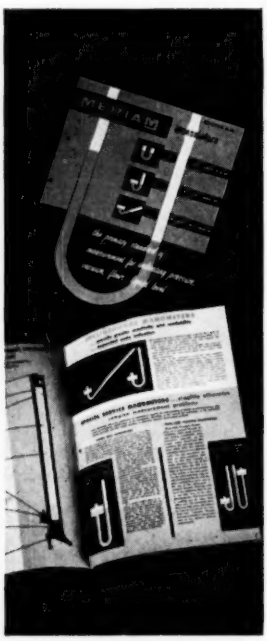

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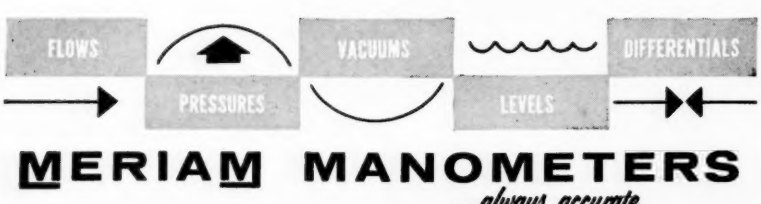
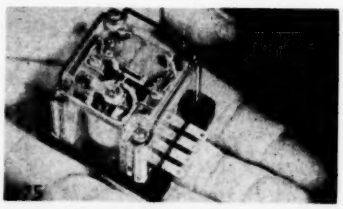
Cleveland 2, Ohio

In Canada: Peacock Brothers, Ltd.



For more information circle **105** on inquiry card.

NEW INSTRUMENTS



through its contacts. Feature is "contact memory": pm-mc movement's pointer deflects in proportion to signal; when signal reaches preset limit, gold-plated contact on pointer is attracted to and strikes fixed contact which is a small magnet. To separate the contacts, power is applied to a reset coil. Available with single or double limits.—*Assembly Products, Inc., Chesterland, Ohio.*

For more information circle **316** on inquiry card.

MOTORS, etc.

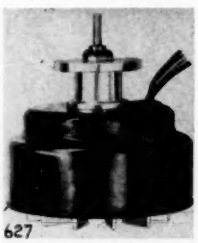
SYNCHRONOUS MOTOR

525

New Type 18-A-8125-01 size 18 single-phase two-capacitor type 400-cps synchronous motor runs at 12,000 rpm; has 0.85 oz-in pull-out torque with 20-watt power consumption, thus delivering unusually high torque on low wattage. It meets Mil-E-5272; weighs 14 oz.—*John Oster Mfg. Co., Avionic Division, Racine, Wis.*

For more information circle **317** on inquiry card.

THREE-SPEED MOTOR



627

New 3-speed hysteresis motor for tape recorders, computer storage drums, turntables, etc. provides tape speeds of 3¾, 7½ and 15 ips with a direct drive. Precision-ground capstans held to close concentric and diametral tolerances are integral with rotor shaft to maximize accurate velocities and minimize flutter.—*Technical Electronics Corp.*, 4060 *Ince Blvd., Culver City, Calif.*

For more information circle **318** on inquiry card.

GEAR MOTORS

New line of integral horsepower gear motors (1 to 30 hp) and related transmissions are offered in three basic components: an integral-type unit functionally equivalent to previous GE designs where gear and drive motor are packaged into a single unit; an all-motor type which fea-

tures drive motor coupled to gear reducer and mounted on a common carrier; and a separate helical speed reducer which can be used with a variety of prime movers.—*General Electric Co., Schenectady 5, N. Y.*

For more information circle **319** on inquiry card.

AI-FOIL SOLENOID

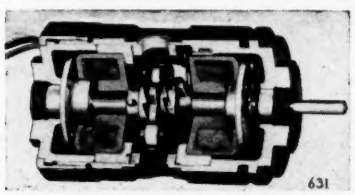
New solenoid, by virtue of its aluminum foil winding, has an extremely uniform field and is much

lighter in weight than conventional units. Typical application: focusing traveling wave tubes and klystrons. —*Jobbins Electronics*, 771 *Hamilton Ave., Menlo Pork, Calif.*

For more information circle **320** on inquiry card.

STEPPING MOTOR

New bidirectional motor translates electrical pulses into accurately uniform shaft-rotation increments by

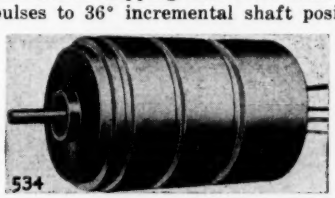


means of two rotary solenoids: energizing either solenoid moves a ratchet axially into mesh and thus imparts constant rotation to output shaft. Detent roller assembly insures reproducible angular shaft-rotation increments in either direction and maintains output-shaft position while motor is at rest with power off.—*Stepper Motors Corp.*, 7444 *W. Wilson Ave., Chicago* 31, *Ill.*

For more information circle **321** on inquiry card.

STEPPING MOTOR

New Syncramental precision bidirectional stepping motor translates pulses to 36° incremental shaft posi-



tions; features a special magnetic clutch, rather than ratchets, to index the shaft. Maximum stepping rate 15 per second; load up to 2 lb-in starting torque at 20°C. Life expectancy 2 million steps in either direction. Temperature range −55°C to 120°C at altitudes up to 90,000 ft.— *G. H. LeLand, Inc.*, 123 *Webster St., Dayton* 2, *Ohio.*

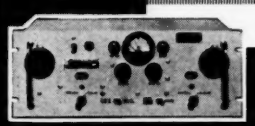
For more information circle **322** on inquiry card.

Measurement Standards

NEW MODEL 1051 C-R-A-M UNIT

Calibrator - Receiver - Amplifier - Mixer

The Model 1051 combines four functions. As a 10 kc to 500 mc frequency standard, it delivers sub-harmonics of a 10 mc oscillator to ±0.0005% accuracy. Discrete sine wave frequencies of 10, 50, 100, 200 kc and 1, 2, 10 mc available from rear terminals. Its 5 mc WWV receiver has a sensitivity of 5 microvolts. The amplifier and mixer sections provide a gain of several hundred times and a comparison of external signals up to 1000 mc or a comparison of external with internal signals. Price $760.



MODEL 531

MODEL 541A

MODEL 459

Crystal Impedance Meters

Four units now available to measure resonance and anti-resonance resistance of quartz crystals, including those covered by Spec. MIL-C-3098B. Capacitance, inductance and performance index (PI) of the crystal can be determined.

Model 531 (TS-683/TSM) covers range of 10-140 mcs, employing 13 calibrating resistors and an anti-resonance adapter for 10-150 ohm crystals. Price $590.

Model 541A (TS-710/TSM) for 10-1100 kc range crystals having resistances from 200 ohms to 0.5 megohms. Power dissipated in the crystal is meaured. Built-in VTVM and ohmmeter provided. Price $860.

Model 459 (TS-330/TSM) covers 1-15 mc frequency range for crystals having resonance resistances from 0 to 9900 ohms. Price $695.

Model 1207 (AN/TSM-15) covers frequency range of 75-200 mcs for 10-125 ohm crystals. Crystal voltage at series resonance is measured and power calculated. Built-in ohmmeter.

All models were developed under Signal Corps technical requirements for the national crystal testing standardization program.

Performance of all models is rigidly guaranteed. Prices are net f.o.b. Boonton, N.J. and subject to change without notice.

SEND FOR TECH. DATA

For additional information, including application data, write or phone DE 4-3100. Demonstrations available by local representatives.

RFL Radio Frequency LABORATORIES, INC. Boonton, New Jersey, U.S.A.

For more information circle **106** on inquiry card.

We Like to Help Control Quality

. . . it's Our Business!

■ Quality control at Lewis Spring is the most important factor in our business—it is present through every department in our plant from receipt of raw materials to final shipping. It is reflected in our engineering and design and equipment maintenance. It is a basic reason why Lewis Spring has so many good customers—they apply quality control in making their products, too. As an example, Lewis Spring was recently presented an award by Argus Cameras Division of Sylvania Electric Products Inc., Ann Arbor, Mich., for "Excellent Co-operation in Controlling Quality." We highly appreciate the compliment.

Lewis Spring would like to help *your* plant control quality . . . and we wouldn't have to get an award for it, because It's Our Business.

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Lewis PRECISION SPRINGS

The finest light springs and wireforms of every type and material

For more information circle **107** on inquiry card.

MECHANICAL COMPONENTS

CRANKS, SHAFTING

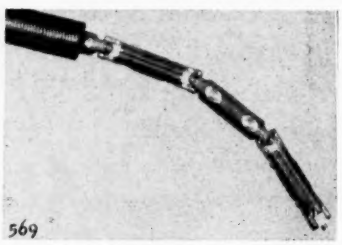
New lines of precision mechanical components include (1) precision hand cranks and a wide variety of

nameplates to fit each hand crank, and (2) precision stainless steel shafting ground to 0.0001" on diameter and finished to 10 microinches. —*PIC Design Corp.*, 477 *Atlantic Ave., E. Rockaway, N. Y.*

For more information circle **323** on inquiry card.

FLEXIBLE SHAFT

New Flexible Link Shaft features three advantages not available in other constructions: (1) equal torque



in both directions, (2) unlimited length and (3) equal flexibility in all sizes. Available cover materials include armored neoprene hose, non-metallic hose or semi-rigid tube. Twelve shaft sizes: ⅜" to 3".—*Clark Flexible Link Shaft Co., Box* 73, *Newton Highlands* 61, *Mass.*

For more information circle **324** on inquiry card.

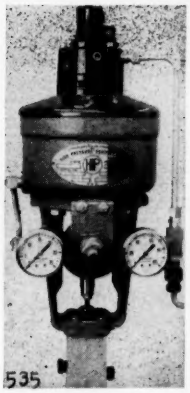
VALVES

MIDGET SOLENOID VALVES

Newly expanded line of 3-way midget size solenoid valves now includes ¼" pipe connections; pressure range to 300 psi; 4 types: universal (pressure at any orifice), normally closed (air service only—valve vents to atmosphere), normally closed (air and liquids), normally open (air and liquids). Valves operate in any position, on voltages up to 550, 25 cps, or 250 vdc. —*Automatic Switch Co., Florham Park, N. J.*

For more information circle **325** on inquiry card.

H-P CONTROL VALVE

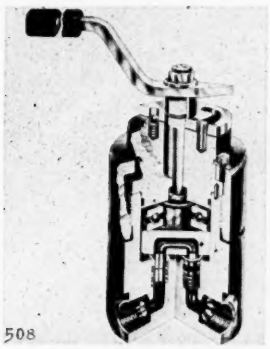


New proportioning control valve features exclusive design aid to provide for greater accuracy by a longitudinal stem lift in line with piston; takes line air pressure up to 100 psi; has removable orifice seat and Cono Control; is made for pressures from 6,000 to 10,000 psi and sizes from ⅛" to ¾", in all types of material; can be supplied in a package with electrical pressure pickups for complete automatic control.—*High Pressure Equipment Co., 1222 Linden St., Erie, Pa.*

For more information circle **326** on inquiry card.

10,000-PSI VALVE

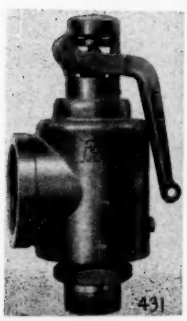
New 10,000-psi four-way valve for liquids and gases utilizes "Shear-Seal" principle; comes in pipe sizes



from ¼" to 1" but can be obtained with tube, AND 10050, or any preferred special high-pressure connection. It will withstand surges up to 15,000 psi without damage to its sealing qualities and is designed for a burst pressure of 30,000 psi.—*Barksdale Valves, 5125 Alcoa Ave., Los Angeles 58, Calif.*

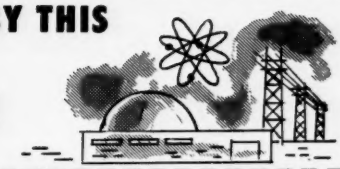
For more information circle **327** on inquiry card.

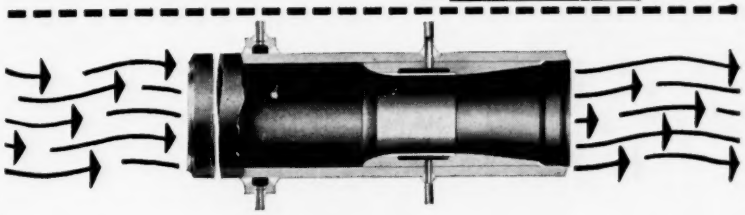
SAFETY VALVES



New series of "Super Capacity" top-guided bronze pop safety valves is for steam generator service and air or gas applications at set pressures up to 300 psi at 450°F. Three styles: 1875 with plain cap; 1875-OL with open lever and 1875-

PRODUCTIVE ATOMS POSED A "HOT" METERING PROBLEM... SOLVED BY THIS BUILDERS FLOW NOZZLE!!





This Flow Meter is in the primary loop of every major atomic reactor in America — from the Nautilus to the Shippingsport Power Plant.

- Only flow nozzle offering the accuracy, range, low head loss, freedom from upstream disturbances, and other desirable characteristics of the Venturi Tube.
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- Designed for high temperature — high pressure applications (power plants, high pressure lines, atomic reactors, etc.).
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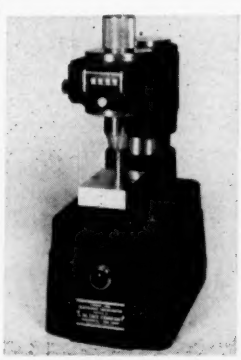

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For more information circle **110** on inquiry card.

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SOLDERING IRONS
—for fast soldering and long life on constant duty

Because of new efficient design, these tiny tips out-perform irons with larger tips and higher wattages. HEXACON offers a new standard in soldering iron efficiency for every conceivable need in the soldering of miniature assemblies.

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For more information circle **111** on inquiry card.

digital clock

The General Automation Model DC-100 Digital Clock provides "time of day" in digital form for data logging applications. The clock maintains time on a 24-hour schedule for recording in straight numeric systems with conventional printers. By means of decimal contact closures, time is diaitized in hours, minutes and seconds. "Time" is also continuously displayed by means of an illuminated inline readout.

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VISUAL IN-LINE READOUT
INTERNAL PRINTER PULSE GENERATOR
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For more information circle **112** on inquiry card.

NEW INSTRUMENTS

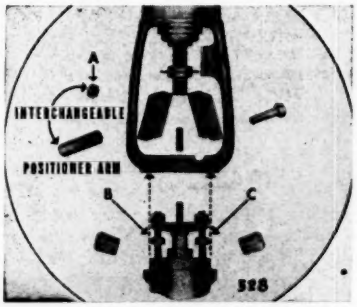
PKS with packed cap and lever. Sizes from ½" to 3", male inlet, female side outlet (flanged inlets on application).—*Farris Engineering Corp., 610 Commercial Ave., Palisades Pk., N. J.*

For more information circle **328** on inquiry card.

ACTUATORS, etc.

VALVE ACTUATORS

New Diaphragm Control Valve Pneumatic Actuators feature new split-coupling which joins actuator



spring stem to valve plug stem. Stems do not engage; by loosening three nuts, actuator can be lifted over plug stem; can be completely removed without disturbing packing box bolting. Coupling has LH (upper) and RH (lower) threads; is a twist-proof clamp for joining stems and acts as a turnbuckle for adjustment of plug seating tension. No valve disassembly is required when positioner is mounted in the field. Three standard sizes, each covering 12 different constructions. Three interchangeable spring ranges: 3-15, 5-25, and 6-30 psi.—*Hammel-Dahl Co., Warwick Industrial Park, Providence 5, R. I.*

For more information circle **329** on inquiry card.

REMOTE VALVE POSITIONER

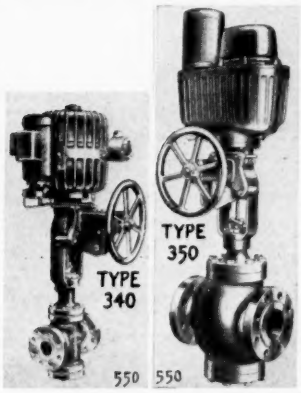
New Val-Con offers exclusive feature of upper and lower valve limit signals plus indication of valve position; operates over leased lines or standard 2-wire and ground systems. Positive indication of upper or lower

valve limits is independent of all normal telemetering functions. Two independent visual alarms signal power failure, pressure, temperature, overload, etc.; an audible alarm unit can be coupled to these visual alarm. —*Sparton Corp., Sparton Controls System Div., Jackson, Mich.*

For more information circle **330** on inquiry card.

VALVE ACTUATORS

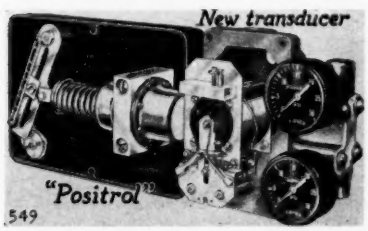
New Electro-Hydraulic Valve Operators are completely self-contained and produce high performance without electronic amplification, using only simple dc-actuated force motors to operate hydraulic pilot. Nozzle-flapper combinations are used in pilot to control hydraulic pressure: no sliding-plate or spool-type valves. Two series: Type 340 can be mounted on valve sizes ½" to 4" and will develop stem thrusts up to 600 lb; Type 350, ½" to 16", 2000 lb.—*Fisher Governor Co., Marshalltown, Iowa.*



For more information circle **331** on inquiry card.

VALVE POSITIONER

New Type 3541 electropneumatic valve positioner features versatility: any of maker's "Positrol" valve positioners now in service can easily be converted to receive an electrical signal and from this operate the pneumatic control valve. New transducer's output is 3-15-psi air pressure; it receives dc signals from any instrument currently on the market. It is temperature-compensated where required so that deviation is less than 1% for a 120F° ambient temperature change. Explosion-proof case is continuously air purged through an explosion-proof vent.—*Fisher Governor Co., Marshalltown, Iowa.*



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SPECIFY POTTER

Potter instruments and systems are unexcelled in reliability, accuracy and flexibility. The equipment shown is typical of many more available as individual components or in integrated systems to meet specific requirements.

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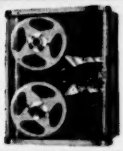
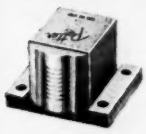

Digital Magnetic Tape Handlers

Perforated Tape Readers

"Quick Look" Recorders


Record-Playback Head Assemblies

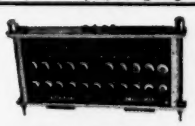
Record-Playback Amplifiers

PRESET INTERVAL GENERATORS

Preset Interval and Delay Generators

HIGH SPEED ACCESS REGISTERS

Ten-Bit Parallel Output (Serial Input) Using Magnistors


Ten-Bit Serial Output (Parallel Input) Using Magnistors

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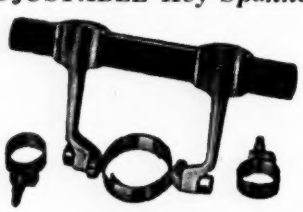

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Accuracy to ±5 seconds

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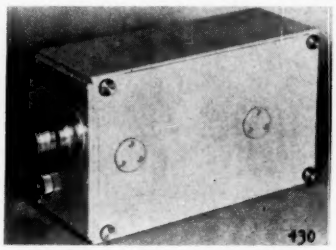
PHOTOGRAPHY

PHOTOGRAPHIC RECORDER

New Model HS-16A 16-mm intermediate high-speed camera has 200-ft film capacity, daylight loading

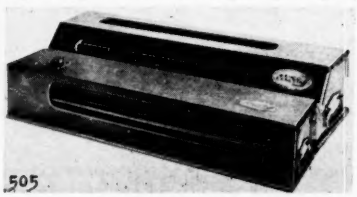


spools, is designed to operate remotely while mounted on aircraft, missiles, sleds, etc. Various optional accessories.—*Photo Instruments Div., Benson-Lehner Corp.,* 11930 *Olympic Blvd., Los Angeles* 64, *Calif.*

For more information circle **333** on inquiry card.

20" PHOTOCOPY OUTFIT

New Exact-Fax Duo, first outfit of its kind that will make photocopies up to 20" wide by any length,



consists of an automatic continuous printer with shutter-type light control, and an automatic continuous processor; operates under all normal office and factory light conditions; eliminates chemical fumes, washing, fixing, drying; makes 60 to 90 copies per hour; makes 1-sided or 2-sided copies; reproduces from all colors.—*General Photo Products Co., Inc., General Photo Bldg., Chatham, N. J.*

For more information circle **334** on inquiry card.

NUCLEONICS

RADIATION DETECTOR

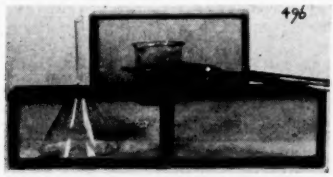
New inexpensive Gard (Gamma Atomic Radiation Detector) for determining presence of harmful radioactive fallout after a nuclear explosion, is to be used principally as a

home survey meter by a family under nuclear warfare conditions or accidental contamination; is believed to be the only radiation detector available that has no tubes, no parts that wear out, no parts that discharge or need charging. It can be stored and be ready for use.—*Sergent-Rayment Co., 4926 E. 12th St., Oakland 1, Calif.*

For more information circle **335** on inquiry card.

RADIATION-SHIELD GLASS

New type of glass shielding brick, as dense as iron, and 2/3 as dense as lead, is inserted in a metallic or



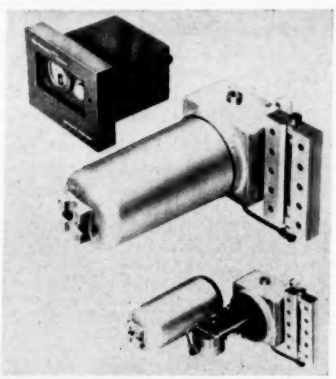
concrete wall to enable worker to observe action, perform remote manipulations, or read instruments. Three sizes of brick are cast, including a large 8" x 8" x 4" block for maximum viewing angle.—*The Atomic Center, Inc., 489 Fifth Avenue, New York 17, N. Y.*

For more information circle **336** on inquiry card.

MISCELLANEOUS

HYGROMETER AND ALARM

New Explosion-proof Model of maker's Electrolytic Hygrometer is designed for industrial instrumenta-

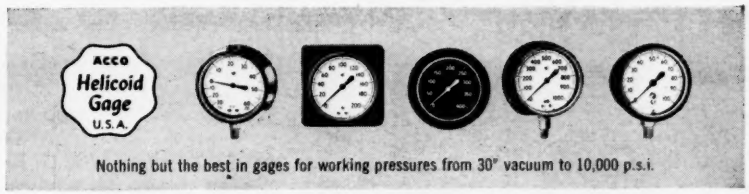


tion in controlling corrosion, product purity and process efficiency. It incorporates a "contact meter" and relay for attaching an alarm system.—*Beckman Instruments, Inc., 2500 Fullerton Rd., Fullerton, Calif.*

For more information circle **337** on inquiry card.

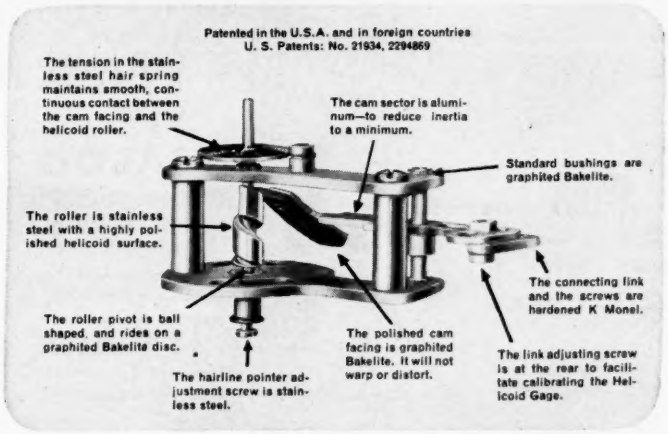
GAS PURIFIER DRYER

New Deoxo Dual Puridryer DMS, said to be the first fully automatic gas purifier and dryer capable of operating indefinitely without attention, can deliver hydrogen with an



Nothing but the best in gages for working pressures from 30" vacuum to 10,000 p.s.i.

These details of Helicoid gage design assure longer life and enduring accuracy


Patented in the U.S.A. and in foreign countries
U. S. Patents: No. 21934, 2294869
The tension in the stainless steel hair spring maintains smooth, continuous contact between the cam facing and the helicoid roller.
The cam sector is aluminum—to reduce inertia to a minimum.
Standard bushings are graphited Bakelite.
The roller is stainless steel with a highly polished helicoid surface.
The connecting link and the screws are hardened K Monel.
The roller pivot is ball shaped, and rides on a graphited Bakelite disc.
The polished cam facing is graphited Bakelite. It will not warp or distort.
The link adjusting screw is at the rear to facilitate calibrating the Helicoid Gage.
The hairline pointer adjustment screw is stainless steel.

The superiority of Helicoid Gages is most evident in severe service—wherever a gage is subjected to violent pressure pulsations or severe mechanical vibrations.

The *sustained accuracy* of Helicoid Gages over *millions of cycles* is explained by the details of design and construction of the Helicoid movement shown above. Such Helicoid features—protect against wear and corrosion and assure sensitivity, sustained accuracy and trouble-free operation.

Easiest adjustment and calibration

Only Helicoid Gages have the external pointer adjustment pictured here. The Helicoid type adjustment cannot be jarred out of position.

Calibration of Helicoid Gages is accomplished easily, without removing dial or pointer, because the link adjusting screw is at the rear of the system.

Tubes built for millions of pressure pulsations

To fit the wide range of applications, Helicoid Bourdon tubes are available in four materials —alloy steel, K Monel, stainless steel and phosphor bronze.

All Helicoid tubes are made from seamless tubing and are carefully designed to give maximum torque and minimum stress. When used within the dial range, they will withstand many millions of pressure pulsations and will not stretch, leak or crack.

For complete information on the Helicoid line of gages write for **Catalog G-52**

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For more information circle **117** on inquiry card.

PRESET COUNTER
By FREED

The Freed Model 2020 Preset Counter is designed for low cost reliable counting applications, where accuracy and maintenance-free operation is required.

Cold cathode counting and trigger tubes, with simplified circuits, are used throughout which assure years of trouble-free counting service and low-power consumption.

Model 2020 is a 4-digit single preset counter capable of controlling any operation that is repeated up to 9,999 times. Any number from 1 to 9,999 may be preset on the 4-digit selector switches. When the preset total has been reached, the counter will provide an output pulse and close contacts on a relay. These outputs may be used simultaneously or separately to stop machines, actuate control signals, or trigger additional equipment.

SPECIFICATIONS

Maximum Count: Four digits — 9,999
Maximum Counting Rate: 300,000 counts per minute
Input Sensitivity and Waveform: Not critical
Outputs: Relay contact 10 Amperes Pulse output 50 volts
Size: 8 x 6 x 12 inches
Weight: 11 pounds
Power: 25 watts 105-125 volts, 50-60 cycles
Price: $425.00

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For more information circle **120** on inquiry card.

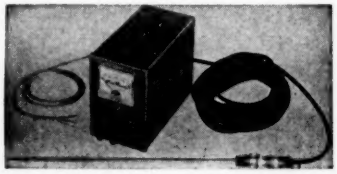
NEW INSTRUMENTS

oxygen content of less than 1 ppm and a dew point of better than −100°F; can be used also with N, He, A, CO_2 and saturated hydrocarbons.—*Baker & Co., Inc., 509 Madison Ave., New York 22, N. Y.*

For more information circle **338** on inquiry card.

ANEMOMETER

New hot-wire anemometer features frequency response of dc to 1000 cps, noise level less than 1% of mean



flow level, no batteries, no time constant testing or gain settings.—*Aero Research Instrument Co., 315 N. Aberdeen St., Chicago 7, Ill.*

For more information circle **339** on inquiry card.

LIFETIME LUBRICANT

New Custom Lube 101L, for instruments and precision machinery, has a life free from gum or oxidation of 15 years and will prevent wear under extreme loads. Residual oil film from a spray, dip, or brushing is sufficient for lifetime lubrication.—*Custom Lubricant Co., 743 Dwight Way, Berkeley 10, Calif.*

For more information circle **340** on inquiry card.

RATE GYRO

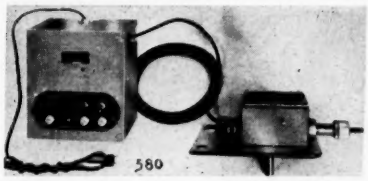
New Model RG15-0102-1 rate gyro features simplified design, extremely light-weight efficient motor, accurate

trouble-free damping, choice of inductive or voltage-dividing resistor pick-off; is available with AN connector or new pigmy connector.—*Humphrey Inc., 2805 Canon St., San Diego 6, Calif.*

For more information circle **341** on inquiry card.

SLEET AND ICE ALARM

New Aminco Sleet and Ice Alarm System represents a new method of providing protection against the for-



mation of ice on various outdoor installations; solves such diversified problems as poor radio and TV transmission due to tower icing, freezing of gas-line pumping stations, etc. It detects climatic conditions favoring formation of ice, and automatically actuates defrosting heaters or provides a visual alarm for the manual actuation of heaters.—*American Instrument Co., Inc.*, 8030 *Georgia Ave., Silver Spring, Md.*

For more information circle **342** on inquiry card.

MINIATURE LIGHT SOURCE

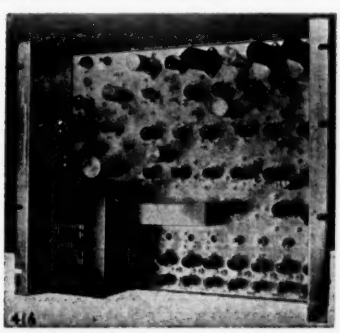
New Model 6375 light source, designed for close-proximity use with miniature phototubes and photocells,

can be mounted in a $\frac{11}{16}$" hole; operates on a nominal 0.15-amp input of 6.3 v ac or dc; features easy access to miniature bayonet base lamp by removing knurled protective ring.—*Autron Engineering, Inc.*, 1254 *West Sixth St., Los Angeles* 17, *Calif.*

For more information circle **343** on inquiry card.

SYNCHRONIZING GENERATOR

New Model APG-4R RETMA Phantastron Synchronizing Generator is designed for broadcast studios re-



quiring maximum dependability; is available in a suitcase package for field use (Model APG-4).—*Kin Tel*, 5725 *Kearny Villa Rd., San Diego* 11, *Calif.*

For more information circle **344** on inquiry card.

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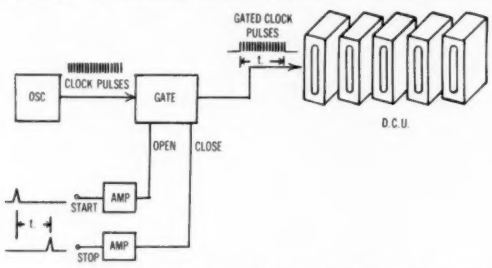
For more information circle **121** on inquiry card.

Briefs

For this literature circle number on inquiry card.

Time Interval Meter

The Time Interval Meter is an electronic counter that measures the elapsed time between any two events of an electrical, mechanical, or optical nature which can be translated into a voltage change . . . A crystal controlled oscillator is used to generate precise clock pulses which are counted by decimal counting units. . . . Time interval

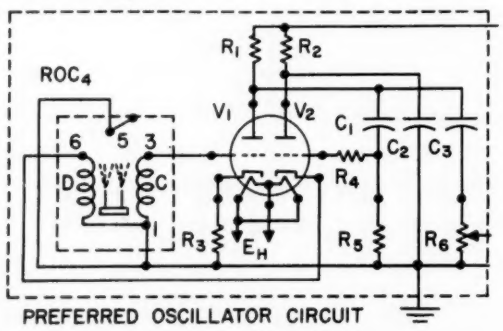


measurements made with an electronic timer have proved efficient and accurate for testing and recording the shutter speeds of cameras . . . a measurement is made of the time a point in the film plane is exposed to light as the shutter opens and closes. The phototube output is too low to produce a signal of sufficient strength to directly drive the Time Interval Meter; therefore, a preamplifying stage is incorporated in the detecting unit. This preamplifier may be either the DC or AC type . . . (*From new* 12-*page Data File* 112 *Beckman/Berkeley Div.*, 2200 *Wright Ave., Richmond, Calif.*)

For this literature circle **401** on inquiry card.

Resonant-Reed Oscillator

A resonant-reed oscillator control is a small inexpensive electro-mechanical device for use in electric oscillators. It keeps the oscillator output frequency within close limits... This device can also be used without any modification as an electro-mechanical bandpass filter. Type ROC controls can be made with any one nominal control frequency between 20 and 1100 cps. When operated in the circuits specified in this bulletin, oscillator controls will keep the output frequency of these circuits constant within ±0.15% of the nominal control frequency with which the unit is designated.



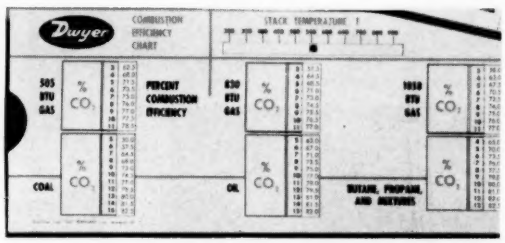
PREFERRED OSCILLATOR CIRCUIT

The basic element of the control is a miniature tuning fork. It consists of two nickel alloy reeds brazed into a metal bar . . . This tuning fork is mounted between elastic supports on a structure which is fastened to a metal base plate. Two wire wound coils are mounted on this structure so that one reed passes through the center of each coil. A small permanent magnet is secured to the top of each coil in such a manner that the tip of the reed can oscillate freely in the air gap of the magnet.

When plate and filament voltage is applied to the tube in this circuit, current passes through the drive coil D. This current creates a magnetic flux in the reed which momentarily polarizes it and the tip of the reed momentarily becomes a magnetic pole. The poles of the permanent magnets, mounted on the coils of the control unit, exert a force on the polarized tip of the reed. Plate current of tube V_1 will oscillate with exactly the same frequency as the reeds in the oscillator control. (*From new*, 12-*page Bulletin* 34-28, *James G. Biddle Co.*, 1316 *Arch St., Phila.* 7, *Pa.*)

For this literature circle **402** on inquiry card.

Combustion Efficiency Chart



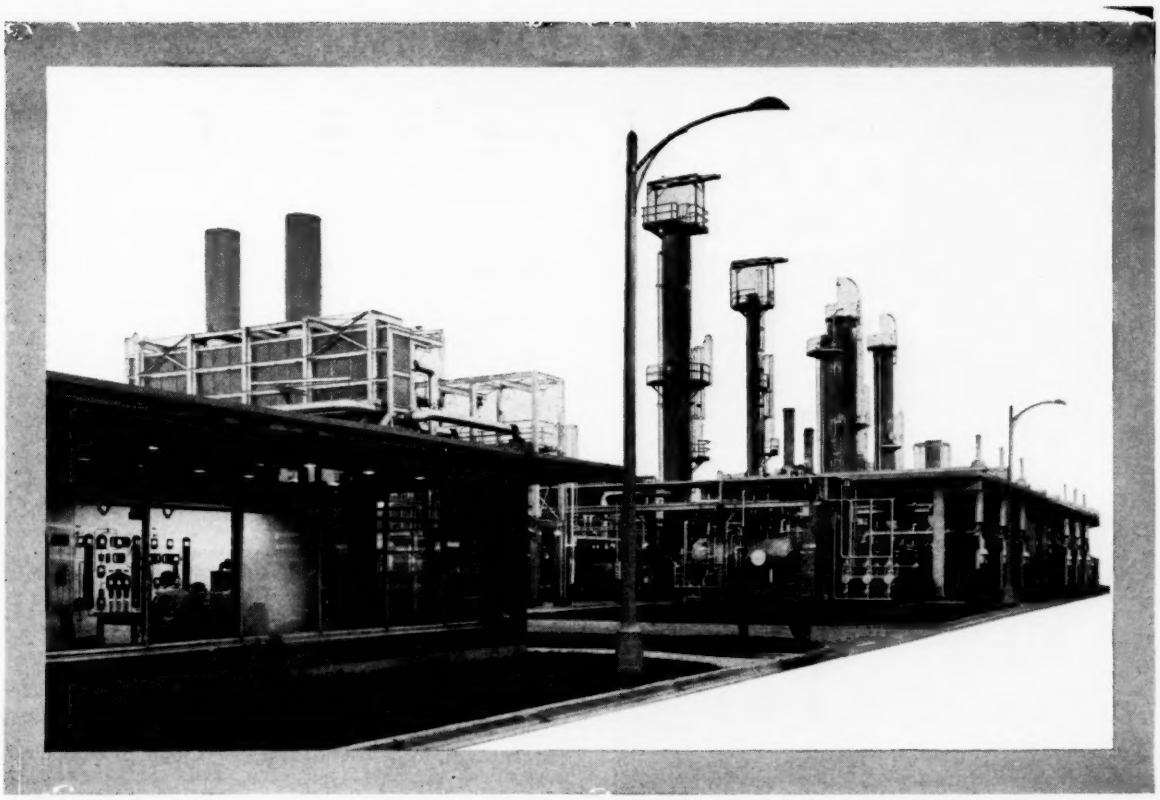
Set the black ball under the stack temperature reading. Read the percent combustion efficiency opposite the CO_2 percentage in the square for the fuel being burned. For example, the combustion efficiency of an installation burning 505 BTU gas at a stack temperature of 400° with 8% CO_2 is 79.5%. . . (*From "Combustion Efficiency Chart" slide-rule calculator, F. W. Dwyer Mfg. Co., P. O. Box* 373, *Michigan City, Ind.*)

For this literature circle **403** on inquiry card.

Printed-Circuit Soldering

All liquid fluxes, whether they are "pure Rosin" or some other, are corrosive and electrically conductive *as long as they are liquid;* this is due to ionizing power quent evaporation, that the flux is deprived of its capacity (Dielectric Constant) exerted by the solvent in dissociating the Rosin or Resin into active ionic constituents that are capable of chemical action. It is only when the solvent is removed, either by the heat of soldering or by subseto ionize and is rendered inactive. In using any flux for printed circuit soldering, it is therefore essential that the solvent be quantitatively volatilized at the temperature of soldering, in order to yield a dry and resinous—and therefore non-corrosive and non-conductive—residue. A common misconception is that "the activated rosin must be heated to volatilize the activating agent". This view is erroneous; it is the solvent—not the activating agent—that must be volatilized.

Conventional methods of flux application, in which the unit is dipped or brushed with flux, invariably result in greatly excessive volumes of applied flux on the laminate assembly. This excess, which is often of the order of several hundred percent, creates not only a problem in appearance, but increases the hazard that there may be



Electronic Control SAVES THOUSANDS OF DOLLARS even before start-up

Here is how: The installation of 'American-Microsen' Electronic Controls eliminated the need for a new control house when a new platformer unit was erected at the Pontiac Refining Corporation in Corpus Christi, Texas.

The existing control house (shown above) is far from the site of the new unit. Transmission distances up to 800 feet were involved—distances too great for conventional process instrumentation. But 'American-Microsen' Electronic Instruments are completely unaffected by distances up to 30 miles. Accurate dc signals are transmitted over simple 2-wire circuits with split-second speed. Consequently, Pontiac found it both practicable and economical to install the new platformer instrument panel right in the existing control house.

In addition, transistors, printed circuits and miniaturized components provide the ultimate in reliability, service life and space-saving simplicity. These are but a few of many reasons why 'American-Microsen' — the all-electronic system that uses only three units — is widely preferred for measurement, transmission and control. Write for literature and ask that a sales engineer from our nearby district office call and explain fully. No obligation, of course.

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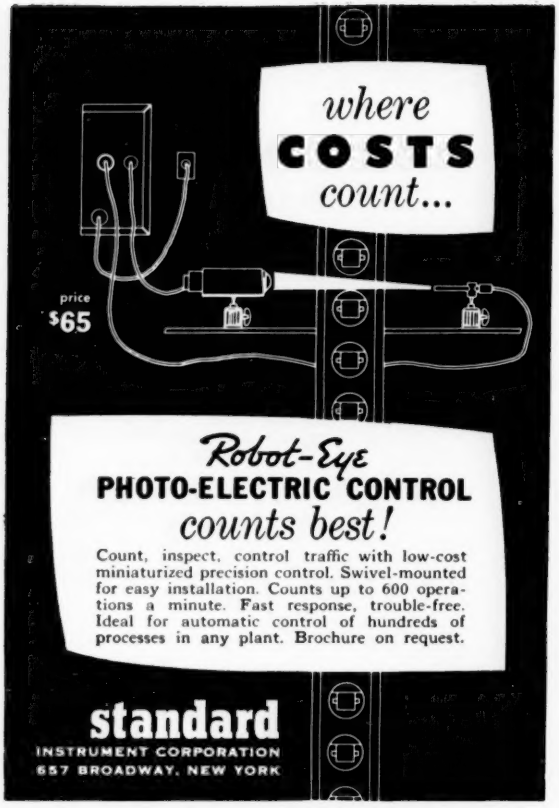
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For more information circle **124** on inquiry card.

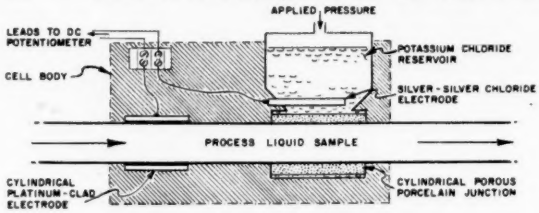
BRIEFS—CONTINUED

retained in all this residue, sufficient solvent to cause a low-resistance value. For relief of this situation, 3 genera' procedures are available: (*From new* 12-*page brochure "Printed Circuit Soldering," Kester Solder Co.,* 4201 *Wrightwood Ave., Chicago* 39, *Ill.*)

For this literature circle **404** on inquiry card.

O-r-p Cell

Oxidation-reduction-potential (o-r-p) is measured with an electrode assembly consisting of an inert-metal electrode and a reference electrode. These electrodes are connected to a potentiometer to complete the measuring system . . . Oxidation-reduction-potential measurements are



PICTORIAL CROSS SECTION OF ORP CELL

useful in any chemical process where it is desirable to follow the changes in relative concentrations of the oxidized and reduced forms of a substance. In chemical processes where the change is brought about by the addition of an agent, o-r-p measurements contribute to economical operation by indicating precisely when the end-point of the reaction has been reached . . . (*From new* 4-*page Bulletin* 17*B*100, *Fischer & Porter Co., Hatboro, Penna.*)

For this literature circle **405** on inquiry card.

For more information circle **125** on inquiry card.

Differential Refractometers

One of the factors greatly affecting the refractive index of a material is the wavelength of light used. To eliminate dispersion effects and to make accurate calibration possible, all Phoenix Differential Refractometers are equipped with a variable monochromatic light source which

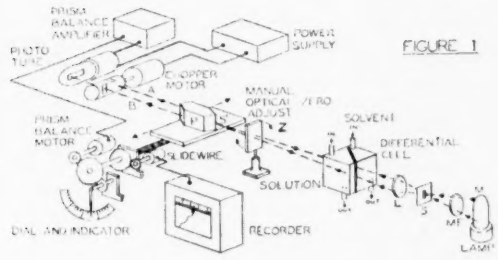


FIGURE 1

allows operation at wavelengths 406, 436, 546, and 578 mu plus other wavelengths and white light if desired . . . In designing the instrument, the photomultiplier tube was preferred over conventional gas type phototubes, barrier layer cells, and other varieties of low sensitivity vintage. The high sensitivity of the photomultiplier tube substantially extends the useful range of the refractometer as the instrument can be used for refractive index measurements on dark as well as clear liquids and gases. . . . (*From new 8-page Bulletin R1000 Phoenix Precision Instrument Co., 3803-05 N. Fifth St., Phila. 40, Pa.*)

For this literature circle **406** on inquiry card.

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They are of utmost importance to the accuracy and dependability of your instrumentation. Burgess-Manning has made a specialty of such devices as: Venturi Tubes—Open Flow, Venturi Insert and ASME Nozzles — Flume Liners, Weir Plates and Orifice Plates, offering you a wide selection including many patented features to provide greatest metering accuracy. Write for complete details.

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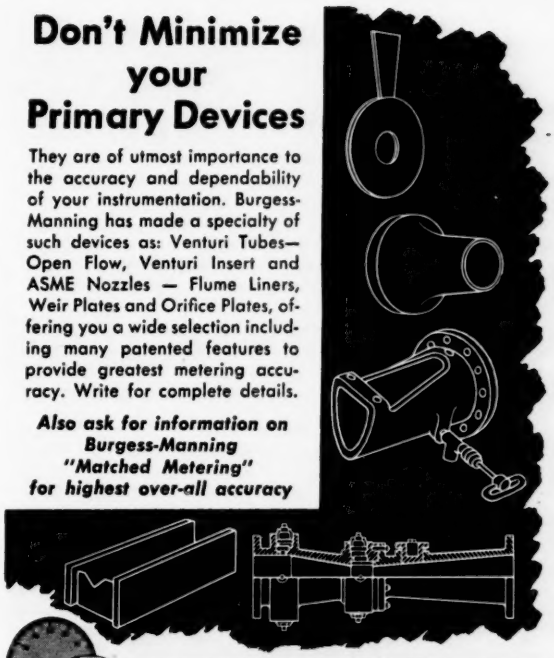

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AGASTAT allows you to stagger the starting of three motors without imposing their load on the line at the same time.

The AGASTAT is
- electrically actuated, pneumatically timed.
- light, versatile, dependable.
- instantaneous recycling.
- adjustable in timing from 0.1 second to more than 10 minutes.
- available in AC or DC models which offer delays on energizing and de-energizing, manually-actuated time delay switch, remote push button control, hermetically-sealed units.

Write our application engineers for help with your timing problem. Address Dept. A25-109

AGA DIVISION

Elastic Stop Nut Corporation of America

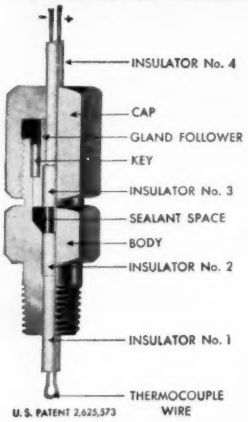
1027 Newark Avenue, Elizabeth, New Jersey
Pioneers in pneumatic timing.

For more information circle **129** on inquiry card.

Fast Response

conax®

BARE WIRE THERMOCOUPLE GLANDS



U.S. PATENT 2,625,573

provide the only simple positive method for sealing two or more bare wires at pressures from full vacuum to 20,000 psi.

Low mass, unshielded, bare wire thermocouples give almost instantaneous response to temperature changes assuring greater accuracy of measurement and control.

- **Temperature range—−300°F to +1850°F**
- **All stainless steel construction**
- **Complete range of sizes**
- **Available from stock**

WRITE FOR CONAX DATA BOOK SHOWING COMPLETE LINE OF THERMOCOUPLE ASSEMBLIES AND PRESSURE SEALING GLANDS.

conax corporation
2316 Walden Avenue, Buffalo 21, N. Y.

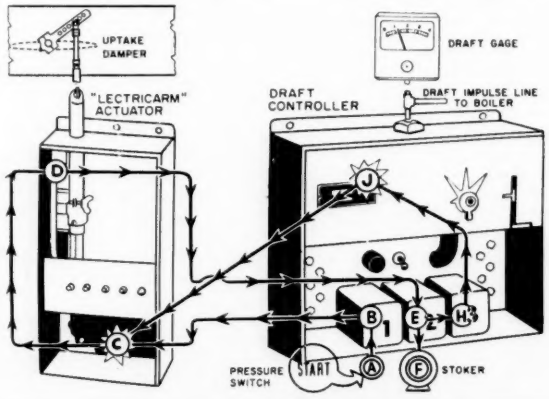
For more information circle **130** on inquiry card.

BRIEFS—CONTINUED

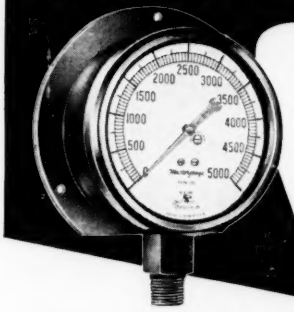
Sequence Draft Control Systems

Functioning of an automatic Sequence Draft Controller is based on sensing of furnace pressure conditions . . . Combustion control systems may be electric, pneumatic, or hydraulic. An electrical system is preferred for installations where draft control only is required. . .

Steam pressure calls for heat, closing pressure switch (A). Signal goes to No. 1 relay (B), which energizes "Lectricarm" Actuator motor (C) to open uptake damper. When damper is open, with full draft established, the reversible thrust rod actuates limit switch (D), signaling No. 2 relay (E), which then energizes fuel feed mechanism (F) to start firing. At the same time, No. 3 relay (H)



MARSH *Mastergauge*



The gauge that has everything!

- **LEAK-PROOF ONE-PIECE CONSTRUCTION** . . . bourdon tube fused to socket and tip by exclusive "Conoweld" process.
- **STURDY "MARSHALLOY" CASE** . . . formed of boiler-plate-thickness steel, copper clad inside and outside to give it the corrosion resistance of solid copper. It's one third lighter, but four times stronger than cast iron.
- **PRECISION "MASTERGAUGE" MOVEMENT** . . . with such exclusive features as the coined sector gear.
- **AVAILABLE WITH STAINLESS TUBE AND SOCKET** . . . choice of stainless steels and alloys for all corrosive conditions.
- **WITH "RECALIBRATOR"** . . . quickest and best way to keep a gauge accurate.

These features are combined only in "Mastergauge", standard bearer for the broad line of Marsh Gauges . . . each the best of its kind. Ask for data.

MARSH "THE STANDARD OF ACCURACY"

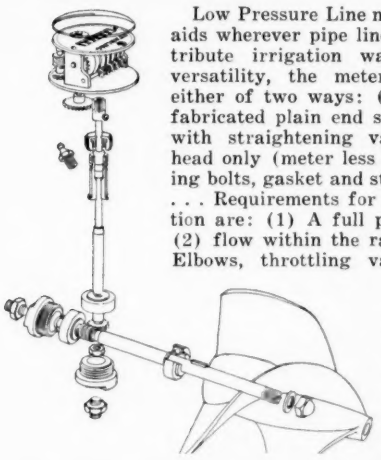
MARSH INSTRUMENT CO., *Sales Affiliate of Jas. P. Marsh Corp.,* **Dept. 8. Skokie, Ill.**
Marsh Instrument and Valve Co. (Canada) Ltd. 8407 103rd St., Edmonton, Alberta.
Houston Branch Plant: 1121 Rothwell St., Sect. 15, Houston, Texas.

For more information circle **131** on inquiry card.

transfers draft control to diaphragm operated switches (J) to establish automatic draft modulation by controlling reversible "Lectricarm" Actuator motor (C) linked to uptake damper, maintaining the predetermined most efficient setting. During the "off" period, modulation draft continues until heat is called for again. . . . (*From new 20-page booklet No. 1 of "Systems Engineering Applied to Combustion Control," Cleveland Fuel Equipment Co., 1111 Brookpark Rd., Cleveland 9, Ohio.*)

For this literature circle **407** on inquiry card.

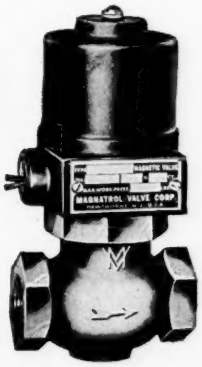
Irrigation Meters



Low Pressure Line meters are valuable aids wherever pipe lines are used to distribute irrigation water. To increase versatility, the meter is available in either of two ways: (1) Complete with fabricated plain end steel tube equipped with straightening vanes; (2) meterhead only (meter less tube) with clamping bolts, gasket and straightening vanes . . . Requirements for accurate registration are: (1) A full pipe of water, and (2) flow within the range of the meter. Elbows, throttling valves, or fittings which might cause a jet or spiral flow into the propeller should be avoided upstream from the meter. . . . (*From new 28-page Bulletin 500, Sparling Meter Co., 225 N. Temple City Blvd., El Monte, Calif.*)

For this literature circle **408** on inquiry card.

Eliminate
Costly Flow Failures



Magnatrol
SOLENOID VALVES

Quick Operating *Non Sticking* *Tight Seating*

These three design advantages are your assurance against costly flow failures. Attain dependable, accurate, automatic or remote control of liquids or gases with **Magnatrol Valves.** Installed quickly and easily in connection with . . . flow-meters, thermostats, float and time switches. **Every Magnatrol Valve** is delivered to you—factory tested—guaranteed free from defects in material and workmanship.

Available in normally closed or normally open models. Pressure ranges from zero up to 300 PSI. Voltages to 575.

Catalog containing complete specifications mailed upon request.

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HAWTHORNE 14 NEW JERSEY

For more information circle **132** on inquiry card.

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The Cambridge Recording Gas Analyzer continuously analyzes and records as many as six constituents of a gas. Eliminates intermittent, slow and expensive manual gas analysis. Accurate . . . Sensitive . . . Simple. No moving parts; utilizes thermal conductivity principle.

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PRECISION INSTRUMENTS

For more information circle **133** on inquiry card.

The New SCHERR MICRO-PROJECTOR with the VERTICAL design

NEW 1957 SELF CONTAINED IMPROVED MODEL

FEATURING

- ✓RIGID FLOOR BASE - ELIMINATING EXTRA CHARGE FOR TABLE
- ✓TILTING STAGE FOR HELIX, ANGLES AND BEVELS
- ✓4" DIA. STAGE OPENING
- ✓14" DIAMETER SCREEN
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- ✓CUSTOM MADE PRECISION COATED LENSES & DOUBLE CONDENSERS FOR DIFFERENT OBJECTIVES 10 TO 100X MAGNIFICATION.
- ✓AN ENTIRELY NEW PRACTICAL DESIGNED TOOL FOR INSPECTION DEPARTMENT AND PRODUCTION SHOP.

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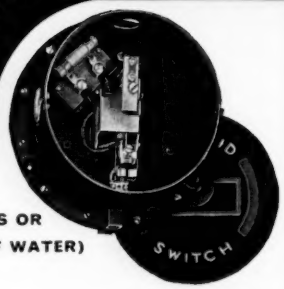
COMPLETE LINE OF PRECISION INSTRUMENTS
200-MG LAFAYETTE STREET • NEW YORK 12, N.Y.

For more information circle **134** on inquiry card.

DIFFERENTIAL PRESSURE CONTROLS FOR LOW PRESSURES

MERCURY SWITCH EQUIPPED



FOR AIR OR GAS (INCHES OR FRACTION OF INCHES OF WATER)

TO OPEN OR CLOSE AN ELECTRICAL CIRCUIT ACCORDING TO A MINUTE CHANGE IN THE DIFFERENCE BETWEEN TWO PRESSURES OR VACUUMS

Mercoid Type PPQ Diaphragm Differential Pressure Controls operate from minute changes (.03" water) in the difference between two pressures.

Ranges to cover most applications (inches of water) 6" vacuum to 6" pressure, and 30" vacuum to 30" pressure. Available for various circuit arrangements.

Electrical Capacity—0.3Amp. at 115V., A.C. or 0.15 Amp., at 230V., D.C. Can be furnished in explosion-proof or weather-proof cases.

WRITE FOR BULLETIN CA-3P

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4201 BELMONT AVE., CHICAGO 41, ILLINOIS, U.S.A.

For more information circle **135** on inquiry card.

TIME YOUR TESTS IN SPLIT-SECONDS!

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ALL PURPOSE LABORATORY TIMERS

MODELS AT $23.95 TO $29.95

You can set the large 8" dial for any desired time period within an unusually wide range of 3600 possible settings, (ie., 1 sec. to 60 min., 1 min. to 60 hrs., etc.). At end of preset interval, alarm sounds and external load is automatically switched on or off.

Gra-Lab Micro Timers, **Electric Stop Clocks,** are available in 1/10 sec. or 1/1000 min. graduations for split-second measurements of elapsed time in laboratory or production operations. Price $37.50

WRITE FOR COMPLETE CATALOG!

DIMCO-GRAY COMPANY

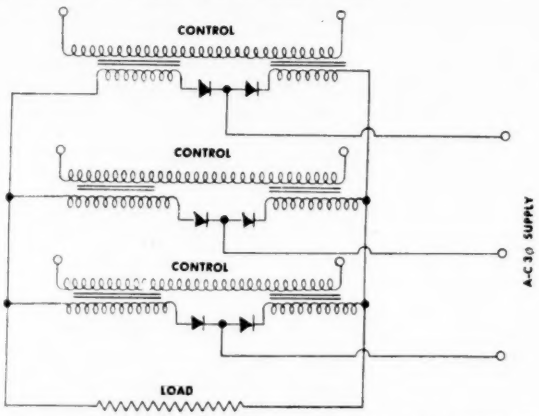
212 E. Sixth St.
DAYTON 2, OHIO

For more information circle **136** on inquiry card.

BRIEFS—CONTINUED

Saturable Reactors

"Control" reactors have high power gains. Six ampere-turns will control nearly 2,000 watts in the largest of these standard reactor assemblies. Power outputs range from 50 to 2,000 watts, with only 2 ampereturns being required for control of the smallest units. . . .



The definition for the figure of merit of a magnetic amplifier is the ratio of the volt-ampere amplification to the time of response. When obtaining this ratio, the same circuit parameters must be used for the measurement of the response time as were used for determination of the volt-ampere amplification. This figure is a true indication of over-all performance and is very useful in evaluating a reactor for various applications. The design of "Control"

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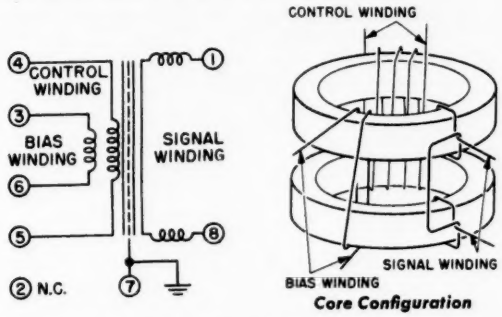
For more information circle **137** on inquiry card.

reactors gives figures of merit of exceptional order. For a typical "Control" reactor, the factor is 1,100 for an N_c^2/R_e of 400. It increases to 1,500 for an N_c^2/R_e of 1,800 . . . (*From new 38-page Catalog R-10, Control, A Division of Magnetics, Inc., Butler, Penna.*)

For this literature circle **409** on inquiry card.

Controllable Inductors

"Increductor" controllable inductors work like saturable reactors, but they operate at frequencies so much higher than conventional saturable reactors that they may quite properly be considered a new circuit component.

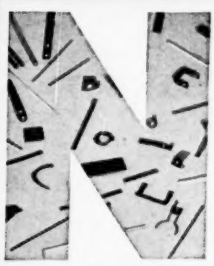


Core Configuration

Series DB units are especially suitable where wide ranges of inductance change are required. An inductance change of 350 to 1 is readily obtained. The units are recommended for starting frequencies between 200 cycles and 200 kilocycles. (*From new 4-page publication "Increductor Notes," No. 1., CGS Laboratories, Inc.,* 391 *Ludlow St., Stamford, Conn.*)

For this literature circle **410** on inquiry card.

NEY'S SMALL PARTS PLAY A BIG PART IN PRECISION INSTRUMENTS



Ney's for "engineered" precious metal contacts, slip rings and alloys

Consult Ney's Engineering Dept. on any problem involving precious metals to improve your products.

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For more information circle **138** on inquiry card.

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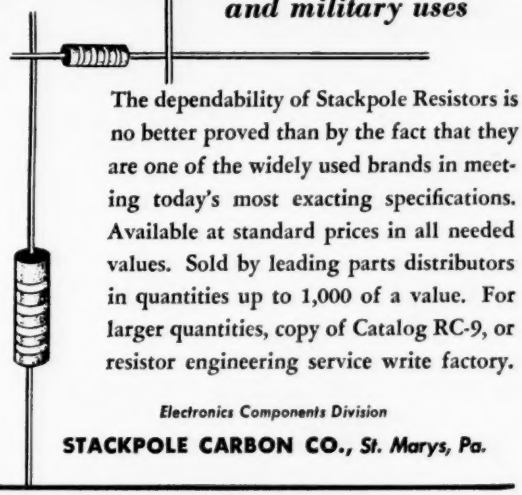
FIXED COMPOSITION RESISTORS

1/2-, 1- and 2-watt types for industrial and military uses



The dependability of Stackpole Resistors is no better proved than by the fact that they are one of the widely used brands in meeting today's most exacting specifications. Available at standard prices in all needed values. Sold by leading parts distributors in quantities up to 1,000 of a value. For larger quantities, copy of Catalog RC-9, or resistor engineering service write factory.

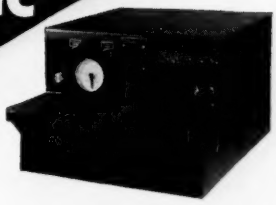
Electronics Components Division

STACKPOLE CARBON CO., *St. Marys, Pa.*

For more information circle **139** on inquiry card.

Ametron®

ELECTRONIC SCALES



Tank scales
Hopper scales
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Truck scales and others

One of the leading steel companies weighs its heavy pipes quickly and accurately. 5, 10, 15 tons of metal weighed and recorded on tape or cards by the Ametron Electronic Scale.

New low costs, improved models. Write for free Ametron Brochure 8.

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GRAYSLAKE, ILLINOIS

For more information circle **140** on inquiry card.

Simplify your job—save time and money. Let our engineers figure out the right relay for your requirements. Just send specifications, we'll submit suggestions promptly. No cost or obligation.

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RELAYS • SOLENOIDS • COILS • SWITCHES • HERMETIC SEALING

For more information circle **141** on inquiry card.

INSULATED WIRE
that will withstand 2000°F

Will last forever in service—eliminating costly replacement

- Available in outside diameters of .04 to .32.
- One or more wires insulated with a pure mineral swaged into a metal tube.
- Can be sharply bent.
- Sheath can be welded without loss of insulation.
- Available in a variety of sheath metals with thermocouples and other wire materials.
- Complete thermocouple probes available using this material made to your requirements.

Write for Bulletin M-1

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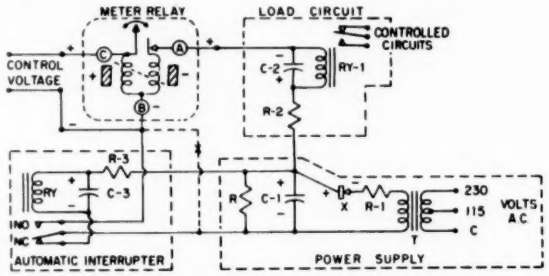
Sales Representatives throughout the United States and Canada

For more information circle **142** on inquiry card.

BRIEFS—CONTINUED

Contact Meter Relays

Meter-relays are indicating meters with built-in relay contacts. One contact is carried on the moving element of the meter—the other on a semi-fixed pointer which can be rotated about the same axis as the moving element . . . A locking coil, integral with the moving element (it is wound on the moving coil), develops additional torque to drive the contacts together with a pressure of 1 to 3 grams. When the two pointers (meter pointer and contact setting pointer) meet, the contacts close and lock because the current carried by the contacts flows through the locking coil . . .



Meter-relays do not "drop out" as conventional relays do when current through the signal coil is reduced. To get "on & off" action, a sampling circuit with an automatic interrupter is generally used. The meter contacts are unlocked periodically to sample the signal current. If the signal is still up to the control point, the meter contacts re-close and lock again quickly. However, if the signal has dropped, the meter contacts remain separated

JUST OFF THE PRESS

CONTROL VALVES

by C. S. BEARD

Covers:	Basic Types
Valve Capacity and Cv	Sizing
Flow Characteristics	Positioners
Mechanical Features	Actuators

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INSTRUMENTS PUBLISHING CO.

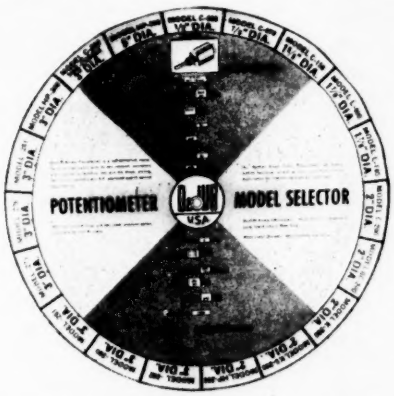
845 Ridge Ave. Pittsburgh 12, Pa.

and the load relay releases. . . Figures shows automatic control in which the load relay holds steady unless the current in the signal coil drops. (*From new 40-page Catalog 4-D, Assembly Products, Inc., Chesterland 1, Ohio.*)

For this literature circle **411** on inquiry card.

Potentiometer Model Selector

Large, 8-¾" plastic coated circular chart has inner rotating wheel that visualizes mechanical and electrical specifications of De Jur's complete line of precision potentiometers. Window cutouts illustrate 19 models and



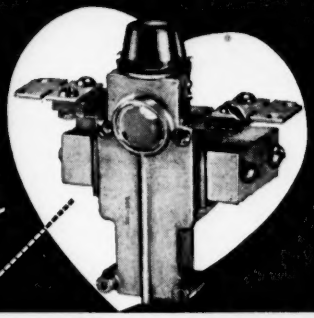
give complete factual data on case materials, mountings, bearings, ganging, housing, resistance, power, linearity, resolution, rotation, and winding. The reverse side of the model selector gives detail specifications of the various elements. (*From Selector Chart, Sales Div., DeJur-Amsco Corp., 45-01 Northern Blvd., Long Island City 1, N. Y.*)

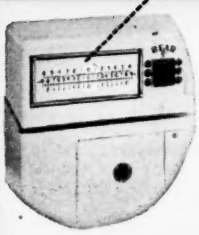
For this literature circle **412** on inquiry card.

Make a GM PORTABLE D'ARSONVAL

GALVANOMETER

the Heart of Your Instrument





IN THE AUTOMOTIVE FIELD, the Bear Manufacturing Co. of Rock Island, Ill. uses Series 500 G-M Galvanometers in its new remote-reading Electric Wheel Alignment System (left). Whatever your own particular instrument field, you can achieve this same self-contained portability, ruggedness and high sensitivity with G-M Galvanometers. Complete catalog on request.

GM LABORATORIES • INC.

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For more information circle **143** on inquiry card.

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*CORNING 707
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FERRITE
FERROX
**FLUORIDE, CALCIUM
**FLUORIDE, LITHIUM
GERMANIUM
INDIUM ANTIMONITE
INDOX
MELAMINE FIBER GLASS
MICA, SYNTHETIC
POTASSIUM BROMIDE
*PYREX
*QUARTZ, CRYSTAL
*QUARTZ, FUSED
**SAPPHIRE
**SODIUM CHLORIDE
**STEEL
STRONTIUM TITINATE
TITANIUM DIOXIDE
*VYCOR
*X-RAY LEAD GLASS
ALL TYPES KNOWN GLASS

*Carried in stock
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100% AUTOMATIC

REMOTE READING
Tank Contents Gauges

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- NO POWER REQUIRED
- UNDERWRITERS' APPROVED

Liquidometers use a temperature compensated balanced hydraulic system. Indications unaffected by changes in specific gravity. All models feature large easy-to-read dials. UL approved switches available.

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Since 1920 ...of proven quality

THE LIQUIDOMETER CORP.

LONG ISLAND CITY 1, NEW YORK

For more information circle **145** on inquiry card.

New Literature

AUTOMATION

NUMERICAL POSITIONING CONTROL. Eight-page Bulletin GEA-6594 describes complete industrial system for automatic point-to-point positioning of machines and machine tools, explains theory and operation of numerical positioning.—General Electric Co., Schenectady 5, N. Y.

Circle **413** on inquiry card.

TORQUE CONTROLLER ("Torque-Trol"), monitoring load of motor-driven machines, is specified in new 2-page Bulletin 9B; "Pulsolite", an industrial electric eye is the subject of 2-page Bulletin 600B.—Electronic Control Corp., 1573 East Forest Ave., Detroit 7, Mich.

Circle **414** on inquiry card.

PHOTOELECTRIC SYSTEMS. Description, Instruction Sheet, Wiring Diagram, and Price list (each 1 page) on Series S5 Electronic-Eye Systems are available.—Basic Controls Co., 1714 Westwood Blvd, Los Angeles 24, Calif.

Circle **415** on inquiry card.

MACHINE TOOL CONTROLS by manual, automatic or numerical systems are outlined in new 24-page bulletin. —True-Trace Sales Corp., 9830 East Rush St., El Monte 57, Calif.

Circle **416** on inquiry card.

SUPERVISOTY CONTROL by transistorized audio-tone transmission system is described in new 4-page Bulletin 240-P4.—Builders-Providence, Inc., 345 Harris Ave., Providence, R. I.

Circle **417** on inquiry card.

MOTOR CONTROL

ADJUSTABLE-SPEED DRIVE. Slide-rule-type plastic device (Gen-169) for selecting "Thymotrol" adjustable speed drives is available from Apparatus Sales Div. District offices or General Electric Co., Schenectady 5, N. Y.

Circle **418** on inquiry card.

MAGNETIC MOTOR STARTERS. Twenty-page publication GEA-6611 contains comprehensive data on radically new NEMA Size 0 and 1 magnetic motor starters.—General Electric Co., Schenectady 5, N. Y.

Circle **419** on inquiry card.

MOTOR CONTROLLERS using thyratrons for ac and dc, and stirres using autotransformers are described with dimensional drawings in new 22-page loose-leaf binder. Contains also price lists.—Gerald K. Heller Company, 1819 Industrial Rd., Las Vegas, Nevada.

Circle **420** on inquiry card.

SPEED CONTROL. Four-page Bulletin R-313 describes "Rev-O-Trol" stepless type which converts ac for d-c motor drive with full load torque at all speeds.—Acme Electric Corp., Cuba, N. Y.

Circle **421** on inquiry card.

VALVES

3-WAY VALVES. Two-page Bulletin 8314 announces new general-purpose midget-size solenoid valves in ⅛" and ¼" pipe sizes for air, gas and many liquids.—Automatic Switch Co., Florham Park, New Jersey.

Circle **422** on inquiry card.

CUSHIONED VALVES and their applications in water-supply-system are described in new 4-page Bulletin G-5. —Golden-Anderson Valve Specialty Co., 1285 Ridge Ave., Pittsburgh 33, Pa.

Circle **423** on inquiry card.

DIAPHRAGM VALVES for pressure and vacuum service, lined and unlined, are described in new 6-page Bulletin 800, containing tables for water capacities.—W. S. Rockwell Company, 200 Eliot St., Fairfield, Conn.

Circle **424** on inquiry card.

TEMPERATURE

TWO-POSITION CONTROLLER. signalling, non-recording, non-indicating, ideal for controlling temperature in electric and fuel-fired furnaces, ovens, some types of chemical processing units, plastic extruding machines, etc. is described in new Preliminary Data Sheet ND47-33(1).—Leeds & Northrup Co., 4934 Stenton Ave., Phila. 44, Pa.

Circle **425** on inquiry card.

KILN INSTRUMENTS. Four-page Data Sheet 705(2) gives complete information about company's equipment for firing-temperature measurement and control in rotary kilns.—Leeds and Northrup Co., 4934 Stenton Ave., Phila. 44, Pa.

Circle **426** on inquiry card.

TEMPERATURE CHAMBER. Two-page announcement describes Model 100/1000 T20, said to be the first to attain wide range of −100°F to 1000°F.—International Radiant Corp., Low Temperature Div., 4 Manhasset Ave., Port Washington, L. I., N. Y.

Circle **427** on inquiry card.

ELECTRIC THERMOSTATS and limit controls, with dimensional drawings, are described and typed in new 4-page Bulletin RT-819.—Robertshaw-Fulton Controls Co., Robertshaw Thermostat Div., Youngwood, Penna.

Circle **428** on inquiry card.

REFRIGERATION CONTROLS recording, indicating, and non-indicating, are illustrated and specified in new 4-page Bulletin 109.—The Partlow Corp., 500 Campion Rd., New Hartford, N. Y.

Circle **429** on inquiry card.

PRECISION CONTROLLER, (accuracy ±0.001°C), power-proportioning type, is described in new 2-page bulletin 58.—Bayley Instrument Co., Box 538, Danville, Calif.

Circle **430** on inquiry card.

FLOW

ROTAMETER DATA. Folder contains two price lists, ten parts lists and two data sheets.—Rotameters for flow measurement and control are described in new 4-page Bulletin 110.—Brooks Rotameter Co., Lansdale, Pa.

Circle **431** on inquiry card.

FLUID METERS. Eight-page Publication 5A-766-38 covers "Veriflow" positive displacement meters and "Veritrol" controller which combines flow-rate control with indicating and totalizing.—The Hays Corp., Michigan City, Ind.

Circle **432** on inquiry card.

ANEMOMETER (manometer) Cell. Model 9580 for very low gas flow is described in 2-page Bulletin AC.—Gow-Mac Instrument Co., 100 Kings Rd., Madison, N. J.

Circle **433** on inquiry card.

POSITIVE-DISPLACEMENT-METER case histories, maintenance rules, installation suggestions, and results of surveys in food and chemical processing industries, are described in new 12-page Bulletin NI-57.—Neptune Meter Co., 19 W. 50 St., New York 20, N. Y.

Circle **434** on inquiry card.

PRESSURE, WEIGHT, ACCELERATION

INDICATORS, "Series SS", for central stations and power plants, to measure draft, pressure, differential gas pressure and temperature, or to function as receivers with pneumatic transmitters for indicating flow, liquid level, density, high pressures and other process variables, are illustrated and described in new 12-page Bulletin MSP-121.—Hagan Chemicals & Controls, Inc., Hagan Bldg., Pittsburgh 30, Pa.

Circle **435** on inquiry card.

PRESSURE TRANSMITTER ("Compu-Tran"), its construction, applications,

mechanical and electrical specifications, dimensions, use in the process industries, etc. are subject to new 2-page Bulletin R-1.—International Resistance Co., 401 North Broad St., Phila. 8, Pa.

Circle **436** on inquiry card.

WEIGHT CONTROL. Twenty-page Catalog 12, titled "Weight, Its Measurement and Control," covers instrumentized weighing of bulk materials; compares batch and continuous processes.—Weighing and Control Components, Inc., 496 Lincoln Ave., Hatboro, Penna.

Circle **437** on inquiry card.

PRESSURE SWITCHES, ranging from 10" WC to 4000 psig in 8 models, also 3 types of differential-pressure switches, all internally adjustable are described in new 24-page Bulletin CGC-601.—Century Electronics and Instruments, Inc., 1333 North Utica, Tulsa, Okla.

Circle **438** on inquiry card.

PRESSURE TRANSDUCER. Model IPG60-15-350, featuring ±¼% error, is specified in new 4-page Bulletin 2145L.—Strain Gage, Model SG2, containing two unbonded electric-resistance strain elements is described in new 4-page Bulletin 2146L.—Statham Instruments, Inc., 254 Carpenter Rd., Hato Rey, Puerto Rico.

Circle **439** on inquiry card.

LIMIT CONTROLLERS. Four-page Bulletin 562 describes Models 561 and 562 for automatic control of weight, size, pressure, flow, etc.—Daytronic Corp., 216 S. Main Street, Dayton 2, Ohio.

Circle **440** on inquiry card.

ANGULAR ACCELERATION GENERATOR. Model AAc-2, for dynamic evaluation tests and calibration of accelerometers is described in new 2-page Data Sheet S-120.—Statham Development Corp., 12411 W. Olympic Blvd., Los Angeles 64, Calif.

Circle **441** on inquiry card.

RUPTURE DISCS. 4-page brochure describes "Impervite" (impervious graphite) rupture discs accurate to 5% of rated burst; contains table giving resistance to 49 acids, alkalics, gases and vapors., salt solutions, etc.—Falls Industries, Inc. Aurora Rd., Solon, Ohio.

Circle **442** on inquiry card.

TIME, SPEED, COUNT

AUTOMATIC TIMERS. Two-page Bulletin PB-271 describes Type 271 manually-set interval timer for driers, ovens, production machines, etc.; 2-page Bulletin PB571 specifies Type 571 cycling timer for built-in applications.—Cramer Controls Corp., Centerbrook, Conn.

Circle **443** on inquiry card.

TIME-OPERATION RECORDERS. Two 8-page bulletins on "Fact-Finder" recorders: one describing a 2-channel model and the other a 30-channel model, and their various uses.—Alden Electronic & Impulse Recording Equipment Co., Westboro, Mass.

Circle **444** on inquiry card.

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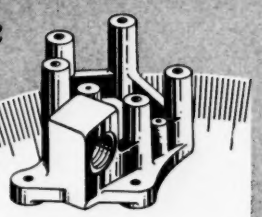

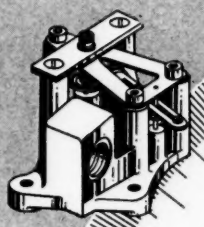

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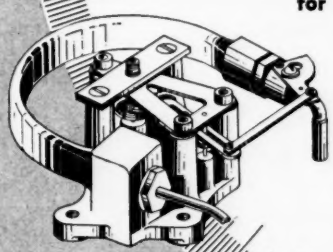

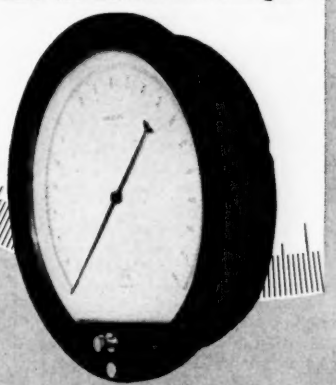

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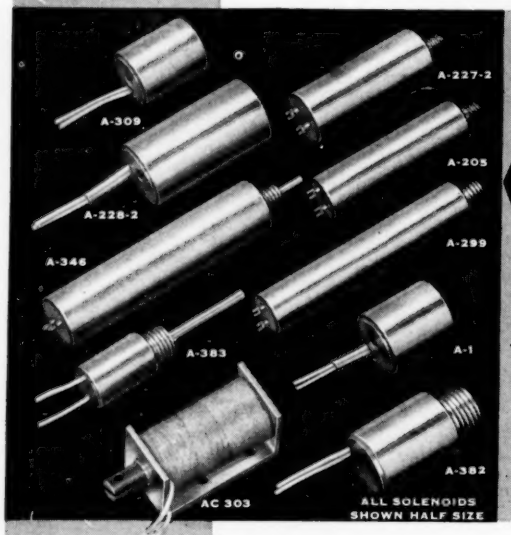

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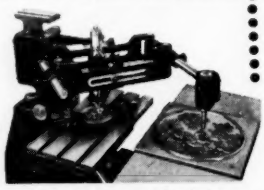

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NEW LITERATURE

ENGINE HOUR METERS which tell at a glance the actual hours and minutes of engine oepration, are described in new 12-page Catalog No. 600.—John W. Hobbs Corp., Div. of Stewart-Warner Corp., 1826 Diversey Pkwy., Chicago 14, Ill.

Circle **445** on inquiry card.

MAGNETIC COUNTER. Two-page Sheet 1158 describes high speed MCRP-700 which adds and/or subtracts electrical pulses and features electrical reset to any predetermined number.—Photocon Research Products, 421 North Altadena Dr., Pasadena, Calif.

Circle **446** on inquiry card.

ELECTRONIC EQUIPMENT. Five 2-page bulletins describe: Model ER-1 Edge register detector; Model F-2 Direct impulse counter; Model PW-5 Five-selection preset counter; Model LF-1A Lineal fostage counter and readouts and Model P3-RM Electronic counter.—Post Machinery Co., Beverly, Mass.

Circle **447** on inquiry card.

STEAM, WATER, AIR

MARINE COMBUSTION CONTROL system consisting of master sender, boiler relay, damper operator; and air-fuel ratio regulator, and oil control valve; is described and illustrated in new 8-page Bulletin MSA-144.—Hagan Chemicals and Controls, Inc., Hagan Building, Pittsburgh 30, Pa.

Circle **448** on inquiry card.

SELF-CLEANING LIQUID STRAINERS are described in 4-page bulletin on the Banks Continuous Strainer, especially designed for the straining of fluids without interrupting the flow for cleaning the screen.—Golden-Anderson Valve Specialty Co., 1291 Ridge Ave., Pittsburgh 33, Pa.

Circle **449** on inquiry card.

AIR CONDITIONING and air distribution controls in combination are explained and illustrated in new 4-page Bulletin F8326.—Barber-Colman Co., Rockford, Ill.

Circle **450** on inquiry card.

GRAVITY FILTER, valveless, for automatic operation in water-treatment plants is illustrated and described in new 8-page Bulletin 4351-5-57.—The Permutit Co., 330 W. 42 St., New York 36, N. Y.

Circle **451** on inquiry card.

AIR FILTER ("Sta-Dri") removing oil vapors from compressed-air and gas lines, available in 8 sizes, is described in new 2-page bulletin, and price list.—Beach Precision Parts Co., 120 Mechanic St., Boonton, N. J.

Circle **452** on inquiry card.

SAFETY CONTROLS for low-pressure steam boilers are described with applications in new 24-page Bulletin 2-711.—McDonnell & Miller, Inc., 3500 N. Spaulding Ave., Chicago 18, Ill.

Circle **453** on inquiry card.

ANALYTICAL, LABORATORY

GAS ANALYZERS for gas purity, mixing and process control by thermal conductivity are described in new 4-page Bulletin PAN 8-57.—Gow-Mac Instrument Co., 100 Kings Road, Madison, N. J.

Circle **454** on inquiry card.

LAB TEST EQUIPMENT is general subject of literature package comprising five 4-page "Newsletter, Vol 4" on Elcometer Dry Film Thickness Gage (No. 30); Vertical Viscometer (No. 31); Interchemical Wet Film Thickness Gage (No. 32); Sherwin-Williams High-Shear Viscometer (No. 33); and 4-page Bulletin 5515-A on Magni-Whirl Utility Baths; also 2-page "Newsletter No. 29" on new Color Difference Meter.—Gardner Lab., Inc., Bethesda 14, Md.

Circle **455** on inquiry card.

LABORATORY balances, made by Sartorius in Germany are described in new 6-page bulletin; relative-humidity chamber ("Blue M Vapor-Temp") is subject of new 2-page Bulletin 5670; and new 2-page Bulletin 5690 deals with "Blue M Testonic" enviromental cabinets.—Boder Scientific Co., 810 Penn Ave., Pittsburgh 22, Pa.

Circle **456** on inquiry card.

pH MEASUREMENTS. Five-bulletin package comprises 8-page bulletin 86-L on Beckman pH electrodes, in simplified chart-form, completely indexed; other bulletins are on the "Zeromatic," Pocket pH, and other Beckman pH meters.—Scientific Instruments Div., Beckman Instruments, Inc., Fullerton, Calif.

Circle **457** on inquiry card.

GAS BLENDER for continuous control of special atmospheres and gas mixtures, etc. is pictured and described in new 2-page Bulletin GB8-57 Gow-Mac Instrument Co., 100 Kings Rd., Madison, N. J.

Circle **458** on inquiry card.

NUCLEONICS

ATOMIC ENERGY PRODUCTS are covered in 8-page bulletin describing valves, etc., designed especially for the nuclear energy field.—Manning, Maxwell & Moore, Inc., 250 E. Main St., Stratford, Conn.

Circle **459** on inquiry card.

LINEAR ACCELERATOR. Mark 1-F4, is subject of new 8-page brochure describing its high energy radiation effects.—Applied Radiation Corp., Walnut Creek, Calif.

Circle **460** on inquiry card.

NUCLEAR MEASURING devices, such as linear amplifiers, pulse-height analyzers, ratemeters, scalers, scintillation counters, etc., are illustrated and specified in new 6-page bulletin.—Technical Measurement Corp., 140 State St., New Haven 11, Conn.

Circle **461** on inquiry card.

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NEW LITERATURE

DATA HANDLING

A/D CONVERTER. all transistorized, for use in Model 112 data handling system is described in new 4-page Bulletin 3007.—Beckman Systems Div., 325 North Muller Ave., Anaheim, Calif.

Circle **462** on inquiry card.

DATA PROCESSING. Five 8-page brochures on applications of the Datatron 205 describe: Pipeline Design (5-03-110); Bridge Design (5-04-120); Mass Spectrometer Data Reduction (5-03-120); Traverse closure (5-04-130); Cut and Fill (5-04-110). —ElectroData Div. of Burroughs Corp., 460 Sierra Madre Villa, Pasadena, Calif.

Circle **463** on inquiry card.

DATA REDUCTION is subject of 4-page brochure on application of "Datatron-Millisadic" Compatible System. —ElectroData Div. of Burroughs Corp., 460 Sierra Madre Villa, Pasadena, Calif.

Circle **464** on inquiry card.

MAGNETIC STORAGE DRUM for "Univac" file-computer system is described in new 6-page Bulletin U1062. —Automatic tape unit with own independent core memory for same system is subject of new 6-page Bulletin U1064.—Remington Rand Univac Div. of Sperry Rand Corp., 315 Fourth Ave., New York 10, N. Y.

Circle **465** on inquiry card.

DIGITIZING AMPLIFIER. Two-page bulletin describes Servo Digitizer Model SL-1004 comprising servomotor, indicator, encoder, servo amplifier and associated circuits.—Industrial Control Co., Wyandanch, L. I., N. Y.

Circle **466** on inquiry card.

MAGNETIC RECORDING system with 300-kc band width for multi-channel portable recording is described in new 2-page bulletin.—American Electronics, Inc., Recordata Div., 9449 W. Jefferson Blvd., Culver City, Calif.

Circle **467** on inquiry card.

CODE CONVERTER. Morse-to-Teleprinter, TRAK Model CMP-16, is described in new 2-page leaflet.—Manufacturing facilities and company background are subject of new 6-page pamphlet.—CGS Laboratories, Inc., 391 Ludlow St., Stamford, Conn.

Circle **468** on inquiry card.

TRANSISTORIZED COMPUTER ELEMENTS for plug-in applications are specified in new 8-page Bulletin C-24. —Ransom Research, 232 West Seventh St., San Pedro, Calif.

Circle **469** on inquiry card.

DIGITAL PULSE DECODER "Secode Type 49" is described in 12-page Manual 102-857.—Electrical Communications, Inc., 765 St., San Francisco 3, Calif.

Circle **470** on inquiry card.

MAGNETIC TAPES for use in telemetering and airborne recording,

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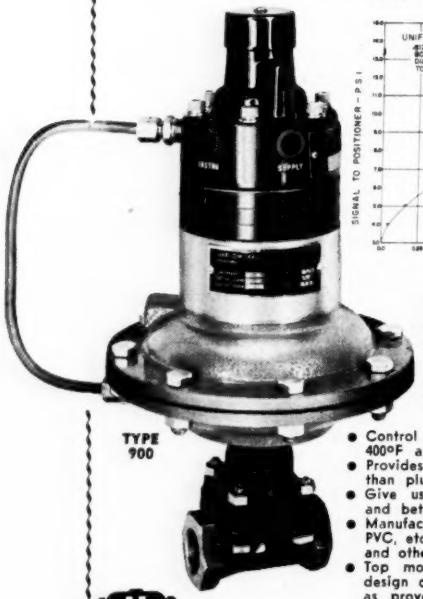

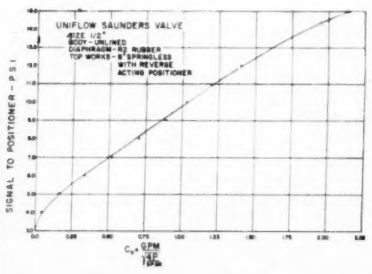

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JAMAICA 35, N. Y.

For more information circle **153** on inquiry card.

machine tool control systems, computers, geophysical recording, etc. are the subject of the new 8-page booklet.—Minnesota Mining and Mfg. Co., Dept. A7-306, St. Paul, Minn.

Circle **471** on inquiry card.

RECORDING

WIND-RECORDING SYSTEM. Four-page Form F-457 describes Wind-Speed and -Direction Recording System with emphasis on atmospheric-pollution application.—Beckman & Whitley, Inc., 1096 E. San Carlos, Calif.

Circle **472** on inquiry card.

OSCILLOGRAPHIC PAPERS. Four-page brochure describes new "Linatrice 3 Thin" and "Linatrice 3 Waterproof" papers offering many advantages.—Grant Photo Products Inc., 19000 Detroit Ave., Cleveland 7, Ohio.

Circle **473** on inquiry card.

RECORDING PAPER is the subject of an 8-page booklet and four 4-page descriptions, data sheets, etc., on Alfax electrosensitive permanent-record paper; high-speed paper is discussed in 7-page technical letter.—Alden Electronic and Impulse Recording Equipment Co., Westboro, Mass.

Circle **474** on inquiry card.

X-Y RECORDER. Model ER-90, a null-seeking servo-type plotter drawing curves in Cartesian coordinates on regular 8½" x 11" paper is pictured and described in new 4-page Bulletin 717-2.—Mandrel Industries, Inc., P. O. Box 13243, Houston, Texas.

Circle **475** on inquiry card.

TESTING, INSPECTING

TRANSISTOR ANALYZER that measures transistor characteristics either by oscilloscope display or VTVM techniques is described in new 4-page Bulletin 387C.—Norden-Ketay Corp., Commerce Road, Stamford, Conn.

Circle **476** on inquiry card.

ENVIRONMENTAL TESTING LABORATORY available to industry and government agencies for critical operating examination of products and systems is described in 4-page Technical Bulletin 58-116 issued by BJ Electronics, Borg-Warner Corp., Santa Ana, Calif.

Circle **477** on inquiry card.

HYDRAULIC TEST MACHINE. completely self-contained unit, for testing and servicing an aircraft's hydraulic system, is subject of new 4-page Bulletin HA-100.—Greer Hydraulics, Inc., New York International Airport, Jamaica 30, N. Y.

Circle **478** on inquiry card.

X-RAY EQUIPMENT. Two-page bulletin describes special industrial x-ray sets for inspection, research, analysis and gaging.—Bracke-Seib X-Ray Co., Inc. 293C Third Ave., New York 10, N. Y.

Circle **479** on inquiry card.

NEW ALL ELECTRONIC Digitizer

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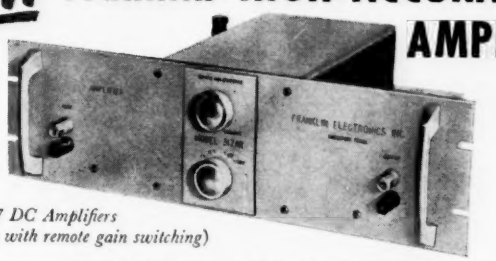
NEW Franklin HIGH-ACCURACY DC AMPLIFIERS



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(Available with remote gain switching)

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BRIDGEPORT, PA.

Electronic & Nuclear Development & Manufacturing

For more information circle **154** on inquiry card.

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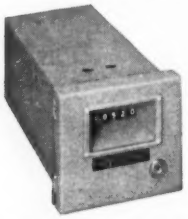

Gilmore Digital Servo Indicator Model 143 supplies a highly readable digital counter type indication of millivolt or resistance changes developed by force, flow, weight, and temperature transducers. Excellent where precise, fast evaluation and high resolution are required. Direct reading eliminates human errors from parallax and interpolation that occur with dial and pointer scales. Accuracy is ±0.1% of span. Indicator case measures 9" x 5⅜" x 14⅝". Write for Bulletin S-5011.

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The new Gilmore Portable Force Calibrator, Model 170, is a direct reading, automatic balance, extended range digital servo indicator that, together with a strain gage load cell, gives a fast, simple method of calibrating existing weight, force, and thrust measuring systems. Direct digital readout requires no interpolation of reading and, in most ranges, no application of correction constants. System accuracy is 0.1% of reading or 0.1% of lowest range, whichever is greater. National Bureau of Standards calibration can be supplied. Unit weighs only 40 lbs., requires no batteries or standardization circuit. Write for Bulletin S-5030.

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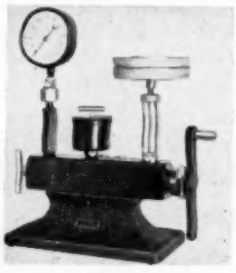

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NEW LITERATURE

INSULATION TESTER is described in announcement of new Model 5250 portable bench 30,000 Vdc Hypot for testing HV insulation characteristics.—Associated Research, Inc., 3758 W. Belmont Ave., Chicago 18, Ill.

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HIGH-VOLTAGE TESTER. Two-page news release covers new Model 122 Electrical Insulation Tester.—Slaughter Co., Piqua, Ohio.

Circle **481** on inquiry card.

VIBRATION TESTING is general subject of literature package consisting of (2) 4-page bulletins on random noise amplifers (190-57 and 200-57) and (2) 2-page bulletins on control consoles (94-57), and power amplifiers (203-57).—The Calidyne Co., 120 Cross St., Winchester, Mass.

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TESTING SERVICE. 24-page booklet and 8-page bulletin describe facilities, classified into (1) Environment, (2) Metallurgy, (3) Chemical and (4) Quality Control.—Burgoyne Testing Laboratories, Inc., 542 Main St., Westbury, L. I., N. Y.

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FITTINGS, TUBING

HOSE FITTINGS. Four-page Catalog 4434 covers reusable "Hoze-lok" no-skive fittings for medium pressure hose.—Tube & Hose Fittings Div., Parker Appliance Co., 17325 Euclid Ave., Cleveland 12, Ohio.

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TUBING. "Wolverine Serves the Refrigeration Industry" is title of 12-page institutional brochure.—Wolverine Tube, Div. Calumet & Hecla, Inc., Guardian Bldg., Detroit 26, Mich.

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TUBE FITTINGS. Four-page Industrial Engineering Bulletin 27 describes 21 different elbow fittings and assemblies.—Aeroquip Corp., Jackson, Mich.

Circle **486** on inquiry card.

CYLINDER-FINISH TUBING is described in 4-page Bulletin R7A on "Rockrite" tubing for applications requiring smooth, close-tolerance I. D.—Tube Reducing Corp., Wallington, N. J.

Circle **487** on inquiry card.

PLASTIC CAPS and plugs for protecting machine screw threads, pipe threads and ends of tubing are cataloged in new 12-page Bulletin P 5708.—S. S. White Plastics Div. 10 E. 40 St., New York 16, N. Y.

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ELECTRICAL, ELECTRONIC INSTRUMENTS

PULSE GENERATOR. "Type 1006," is illustrated and described in new 2-page technical bulletin.—Burroughs Corporation, Electronic Instruments Div., 1209 Vine St., Phila. 7, Pa.

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BOLOMETER PREAMPLIFIER. Two-page Bulletin No. 60 describes Model BA-1A resistance-coupled unit for measurement of RF power ratios up to 30 db.—Two-page Bulletin No. 19 describes Models DS-109, 109L and 109LL for use as variable-ratio frequency impedance transformers.—Weinschel Engineering, 10503 Metropolitan Ave., Kensington, Md.

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R-F EQUIPMENT such as transmitters, modulators, power supplies, and accessories for applications in radar, communications, and tube development are listed and illustrated in new 4-page Bulletin MW 857.—Levinthal Electronic Prods., Inc., 726 Stanford Industrial Park, Palo Alto, Calif.

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TRANSISTORS, RECTIFIERS

SILICON RECTIFIERS for high-current applications are subject of new 2-page leaflet GEC-1470.—General Electric Co., Schenectady 5, N. Y.

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SELENIUM RECTIFIERS for high voltage d-c power supplies are discussed in new 12-page technical paper.—Beta Electric Div., Sorensen & Co., Inc., 333 E. 103rd St., New York 29, N. Y.

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TRANSISTORS, DIODES, rectifiers, regulators, utilizing silicon, also germanium in first two items, are typed and rated in new 6-page Bulletin TE-1320.—Eight silicon-transistors specification and application sheets are contained in loose-leaf folder TE 1353.—Transitron Electronic Corp., Wakefield, Mass.

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PHOTOCELL. Two-page specification sheet describes new 6957 high-sensitivity cadmium-sulfide head-on-type hermetically-sealed photoconductive cell with S-15 response.—Electron Tube Div., RCA, Harrison, N. J.

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TRANSISTOR specification chart lists on 4-pages germanium junction-alloy types.—Industro Transistor Corp., 649 Broadway, New York 12, N. Y.

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AMPLIFIERS

D-C AMPLIFIER. Four-page Data Sheet and 2-page leaflet describe new Model 307-A low-drift d-c amplifier with balanced input.—Allegany Instrument Co., Inc., 1091 Wills St., Cumberland, Md.

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AMPLIFIER. Two-page Bulletin 3001-7 describes Model 672A linear amplifier built to ORNL Spec Q1326; Leaflet 3008-7 deals with specifications of Model 565A micro-micro ammeter electrometer; and Leaflet 3005-7 gives data on Models 695 & 695A single-channel differential analyzer.—The Victoreen Instrument Co., 5806 Hough Ave., Cleveland 3, Ohio.

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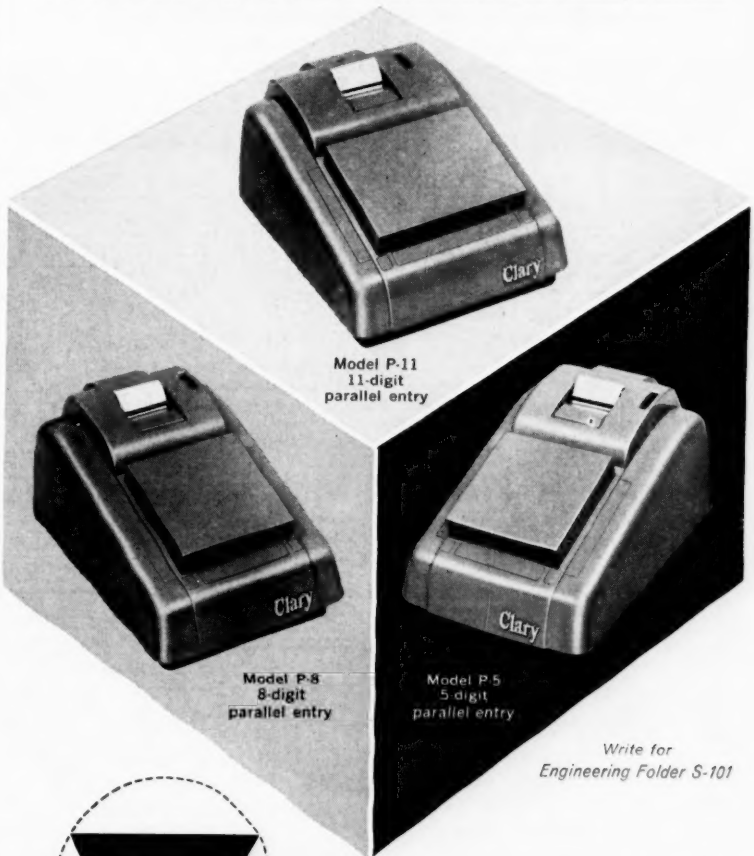

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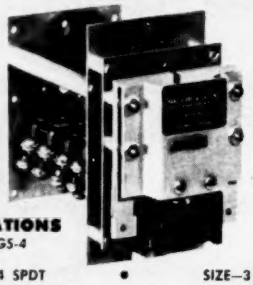

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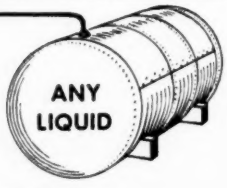

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NEW LITERATURE

D-C AMPLIFIER, general-purpose, Model DA-102, is described in 6-page new bulletin.—Epsco, Inc., 588 Commonwealth Ave., Boston 15, Mass.

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AUDIO FREQUENCY AMPLIFIERS designed essentially for maintenance-free sound systems, scientific laboratories, tape and disc recording equipment, etc. are described in new 12-page Catalog 16-C.—Cinema Engineering Div. of Aerovox Corp., 1100 Chestnut St., Burbank, Calif.

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TRANSISTORIZED AMPLIFIERS are pictured and specified in new 4-page brochure.—Universal Transistor Products Corp., 143 East 49th St., New York 17, N. Y.

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MAGNETIC-AMPLIFIER specifications and applications are presented in new 16-page bulletin.—Dynamics Research Associates, Div. of Universal Match Corp., P. O. Box 5841, Ferguson 21, Mo.

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VISCOSITY

VISCOSITY CONTROL system for adding solvent to correct evaporation losses is described in new 2-page Bulletin No. V-1212.—Norcross Corp., 247 Newtonville Ave., Newton 58, Mass.

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VISCOSIMETER ("Viscometran") for polymerization reactions is described in the new 4-page Data sheet 020.—Brookfield Engineering Labs. Inc., Stoughton 112, Mass.

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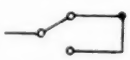
SWITCHES, RELAYS



METER-RELAYS. Twelve-page Bulletin 104-A features new and smaller Model 126 and plug-in "Compact" control.—Assembly Products, Inc., P. O. Box XX, Palm Springs, Calif.

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ROTARY SWITCHES for high-speed telemetering, programming, sampling and scanning with typical contact arrangement and typical circuit applications are described in new 2-page advance bulletin.—Instrument Development Labs. Inc., 67 Mechanic St., Attleboro, Mass.

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SUBMINIATURE COAXIAL SWITCHES. Types 27 and BNC, are described in 2-page specification sheet which includes diagrams and RF data curves.—Cado Mfg. Co., Div. of Electromation Co., 1101 Olympic Blvd., Santa Monica, Calif.

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INERTIA SWITCH, momentarily closing electrical contacts when exposed to horizontal impact or acceleration, is described and specified in new 2-page leaflet.—Safe Lighting Inc., 527 Lexington Ave., New York 17, N. Y.

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SWITCHES of the rotary, slide, and lever type with specifications, data, and dimensional drawings are subject of new 36-page Catalog 42-205.—Centralab, a Div. of Globe-Union Inc., 900 East Keefe Ave., Milwaukee 1, Wis.

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RESISTORS, RHEOSTATS

PRECISION RESISTORS, metal film ("Riteohm Series 77") are described in new 4-page Bulletin 155.—Ohmite Mfg. Co., 3661 Howard St., Skokie, Ill.

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RHEOSTATS. 4-page Bulletin A-4a covers Type Q composition controls, bushings, hardware, switches, torque, resistance tapers, etc.—International Resistance Co., 401 N. Broad St., Phila. 8, Pa.

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PULSE-VIEWING RESISTORS to observe or measure the magnitudes and rise times of current pulses are described in new 4-page Bulletin S-4, International Resistance Co., 401 North Broad St., Phila. 8, Pa.

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RESISTORS. Four-page Bulletin A-3a, gives data on Type 2W Rheostat Potentiometers, and Eight-page Bulletin G-1b contains data on Type MV high-voltage resistors. Fixed resistors: Two-page Catalog Data Bulletin P-4 on Type PW-20 Resistors and two-page P-2c on Types PW-5, PW-7 and PW-10 resistors.—International Resistance Co., 401 N. Broad St., Phila. 8, Pa.

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POWER SUPPLIES

POWER SUPPLY with ripple less than 0.01% of output voltage is described in new Bulletin Sheet 3000-7.—The Victoreen Instrument Co., 5806 Hough Ave., Cleveland 3, Ohio.

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POWER SUPPLIES, voltage regulated, also available for 400-cps operation are described and tabulated in 4-page Brochure B576.—Kepco Labs., Inc., 131 Sanford Ave., Flushing 55, N. Y.

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POWER SUPPLY. Four-page Bulletin 591-A describes 60-watt switching transistor power supply regulated against both line and load variations simultaneously.—Arnold Magnetics Corp., 4613 W. Jefferson Blvd., Los Angeles, Calif.

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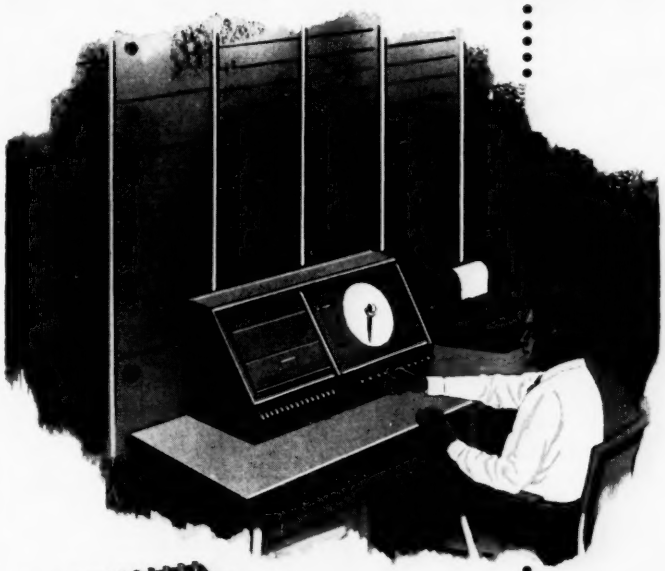

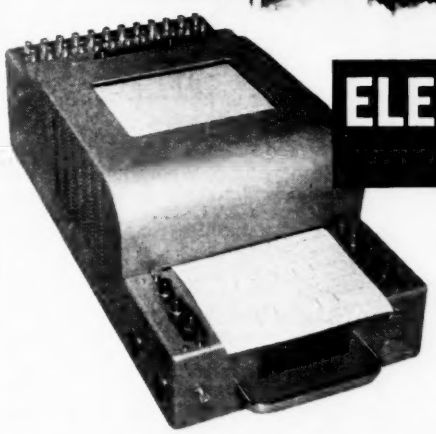

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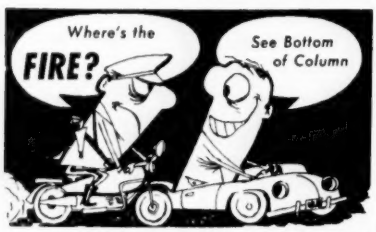

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NEW LITERATURE

TWO-PHASE POWER SUPPLY designed to speed the development and testing of 400-cps servo systems and motors is described in announcement PS2P-1.—Pacific Technical Co., 2047 Sawtelle Blvd., Los Angeles 85, Calif.

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STORAGE BATTERIES. Two-page Bulletin 501A gives characteristics, construction, and discharge curves of "Nicad" sintered-plate nickel-cadmium batteries.—Nickel Cadmium Battery Corp., Easthampton, Mass.

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FILAMENT TRANSFORMERS for automatic, instantaneous voltage regulation of 6.3-v tube filaments to ±1% are presented in new 4-page Bulletin CVF-269.—Sola Electric Co., 4633 W. 16 St., Chicago 50, Ill.

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ELECTRICAL, ELECTRONIC COMPONENTS

CAPACITORS. Two-page Bulletin 152 discusses the unique characteristics of tantalum foil capacitors; applications and limitations of polar and nonpolar types.—Ohmite Mfg. Co., 3655 Howard St., Skokie, Ill.

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CAPACITORS in industrial applications are described in new 12-page Bulletin GEA-5632B.—General Electric Co., Schenectady 5, N. Y.

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TRANSISTOR SERVO AMPLIFIER is title of 4-page brochure giving performance characteristics of 60 and 400 cps "TrAmps," miniaturized units featuring weight factor of less than one ounce per watt.—M. Ten Bosch, Inc., Pleasantville, N. Y.

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TAPE-WOUND CORES said to be consistently uniform are illustrated and described in new 8-page Bulletin TB-102.—G-L Electronics, 2921 Admiral Wilson Boulevard, Camden 5, N. J.

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CLAD METALS. New 2-page Bulletin CM-901 provides information on clad metals, contact materials, and contact assemblies.—American Silver Co., Inc., 35-97 Prince St., Flushing 54, N. Y.

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CAPACITORS. Four-page Bulletin BTS describes encapsulated plastic tubular capacitors for printed circuits.—Pyramid Electric Co., 1445 Hudson Blvd., North Bergen, N. J.

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PULSE CIRCUIT COMPONENTS. such as triggered blocking oscillator circuits, and miniature and subminiature pulse transformers, also engineering kits, are described and specified in 2-page Bulletin 731.—CBC Electronics Co., Inc., 2601 North Howard St., Phila. 33, Pa.

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ELECTRONIC COMPONENTS and equipment are illustrated, described, and priced in new 360-page Catalog 68.—Newark Electric Co., 223 W. Madison St., Chicago 6, Ill.

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CONTROLLED TERMINAL BLOCKS. Binder contains six 2-page and four 4-page bulletins, specifications, etc., on a complete line of terminal blocks.—Marathon Electric Manufacturing Corp., 12th & Cranberry, Erie, Pa.

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THERMOSTATIC FLASHERS are covered in 2-page bulletin describing n-o types for lamp loads and n-c types for inductive loads, with adjusting screw to regulate "on" and "off" time ratio.—Betts & Betts Corp., 213 W. 14th St., New York 11, N. Y.

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PRINTED CIRCUITS. Two 4-page brochures describe direct-printed circuits using silver and carbon components; and company's facilities for printing on all materials.—J. Frank Motson Co., Flourtown, Penna.

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O-RING HANDBOOK Cat. 5700 (160-pages), gives elaborate data on product, made from synthetic rubber.—Available from Parker O-ring Distributors or Rubber Products Div., Parker Appliance Co., 17325 Euclid Ave., Cleveland 12, Ohio.
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THREADED PARTS with nylon inserts for locking, sealing and adjusting, are described and illustrated in new 4-page Catalog NY 571.—Nylok-Detroit Corp., 1100 North Woodward Ave., Birmingham, Michigan.
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FLEXIBLE SHAFTS for solving a wide variety of power transmissions and remote control problems are described and illustrated in 4-page Bulletin 5608.—S. S. White Industrial Div., New York City, N. Y.
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SPRING WASHERS, more than 1,000 different stock sizes, are listed in new 6-page bulletin.—Associated Spring Corp., Bristol, Conn.
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FLEXIBLE LINK SHAFT. Four-page bulletin describes new type claimed to have several exclusive advantages.—Clark Flexible Link Shaft Co., P. O. Box 73, Newton Highlands 61, Mass.
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ELECTRIC BRAKES, designed for fail-safe applications, are described with dimensional drawings in 36-page Report 6293.—Warner Electric Brake & Clutch Co., Beloit, Wis.
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LOCKNUTS are described and illustrated in new 4-page Catalog 2321.—Standard Pressed Steel Co., Jenkintown, Pa.
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BLIND RIVETS. Sixteen-page catalog describes CKL Conical Keystone Lock blind rivets.—Huck Mfg. Co., 2480 Bellevue Ave., Detroit 7, Mich.
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NYLON BOBBINS AND WASHERS. Four-page catalog outlines complete specifications on nylon bobbins and washers.—Cosmo Plastics Co., 3239 W. 14th St., Cleveland, Ohio.
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SELF-LOCKING NUTS. 36-page Bulletin 5711 contains data on miniaturized self-locking nuts for electronic units and avionic equipment.—Elastic Stop Nut Corp. of America, 2330 Vauxhall Rd., Union, N. J.
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TORQUE TOOLS AND TESTERS are described in 28-page catalog; also a 2-page reprint of a technical article; also a 4-page announcement of new Torque Control Clutch.—Livermont, Inc., Myrtle & Maple, Monrovia, Calif.
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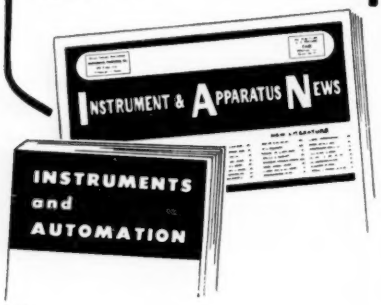

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Applied Science Corp. of Princeton 1990
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Automatic Switch Co. 1841
Autotron, Inc. 1847

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Barksdale Valves 1949
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Bishop & Babcock Mfg. Co. 1857
BJ Electronics, Borg-Warner Corporation 1872
Black, Sivalls & Bryson, Inc. 1843
Bone Engineering Corporation 1964
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Bridgeport Thermostat Division 1861
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Builders-Providence, Inc. 1963
Burke & James, Inc. 1944

Cambridge Instrument Company, Inc. 1975
Century Electronics & Instruments, Inc. 1989
Chace Co., W. M. 1946
Chatillon & Sons, John 1942
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Comar Electric Company 1978
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Conoflow Corporation 1854
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Crawford Fitting Company 1949
Crescent Insulated Wire & Cable Co. 1933
Crystal Glass Tube & Cylinder Company 1984

Dahl Company, George W. 1930
Dice Co., J. W. 1963
Diamond Power Specialty Corp. 1950
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Eastern Air Devices, Inc. 1849
Edison Industries, Inc., Thomas A. Instruments Division 1951
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Engineered Electronics Co. 1932
Eppley Laboratory, Inc. 1836

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Foxboro Company 1879
Franklin Electronics, Inc. 1985
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General Transistor Corporation 1833
Genisco Incorporated 1874
Gilmore Industries, Inc. 1986
G-M Laboratories, Inc. 1979
Goodyear Aircraft Corporation 1817
Gow-Mac Instrument Co. 1943
Graphic Systems 1944
Greiner Co. Emil 1928

Hammel-Dahl Company ..... Back Cover
Hays Corporation 1831, 1990
Helland Division, Minneapolis-Honeywell Regulator Co. 1848
Heise Bourdon Tube Company, Inc. 1981
Helicoid Gage Division—American Chain & Cable Co., Inc. 1967
Hexacon Electric Company 1964
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Ideal Industries, Inc. 1945
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Klipfel Valves, Inc. 1840
Kybernetes Corporation 1915

Leeds & Northrup Company 1870
Leslie Co. 1884
Lewis Engineering Co. 1826
Lewis Spring & Manufacturing Company 1962
Liquidometer Corporation 1979
Levin & Son, Inc., Louis 1815
Lockheed Missile Systems Division 1925
Lynn, Robert M. 1966, 1988

Magnatrol Valve Corp. 1975
Mallory & Co., Inc., P. R. 1868
Manning, Maxwell & Moore, Inc. 1846, 1856, 1866, 1919, 1971
Marsh Instrument Company 1974
Marshalltown Manufacturing Co. 1915
Mercoid Corporation 1976
Meriam Instrument Company 1960
Midwestern Instruments Company 1830-1831
Mine Safety Appliances Company 1824-1825
Minneapolis-Honeywell Regulator Co. Industrial Division 1905, 1906-1907
Moeller Instrument Co. 1949
Moore & Company, Samuel 1850
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Nash Engineering Company ..... Inside Front Cover
Newark Electric Co. 1968
New Hermes Engraving Machine Corp. 1847
Ney Company, J. M. 1977

Ohmite Manufacturing Company 1867
Optical Coating Laboratory, Inc. 1947
Optical Research Corp. 1990
Oster Manufacturing Co., John 1926

Palmer Thermometers, Inc. 1936
Partlow Corporation 1943
Permag Corp. 1963
Petrometer Corporation 1947
Philbrick Researches, Inc., George A. 1844
Potter Instrument Company, Inc. 1965
Precision Tube Company 1934
Preis Engraving Machine Co., H. P. 1982
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Radio Frequency Laboratories, Inc. 1920, 1961
Radio Receptor Co., Inc. 1837
Reeves Soundcraft Corp. 1823
Renick Co., L. C. 1946
Robbins Aviation 1982

Sanborn Company 1839
Scam Instrument Corporation 1927
Scherr Co., Inc., Geo. 1975
Sensitive Research Instrument Corporation 1818
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Skinner Electric Valve Division 1917
Smith Co., S. Morgan 1958
Sorensen & Company, Inc. 1835
Southwestern Industrial Electronics Company 1956
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Stackpole Carbon Co. 1977
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Statham Laboratories 1931
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Streeter-Amet Company 1977
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Superior Tube Company 1842

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Thermo Electric Co., Inc. 1952
Trimount Instrument Company 1973
Trinity Equipment Corporation 1955

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Uniflow Valve Corporation 1889, 1984
United Electric Controls Company 1947
Universal Scientific Company, Incorporated 1968

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Wallace & Tiernan, Inc. 1957
Waterman Products Co., Inc. 1954
Waugh Engineering Company 1924
Weksler Thermometer Corp. 1972
West Coast Electrical Mfg. Corp. 1982
West Instrument Corporation 1959
Weston Electrical Instrument Corporation, a Subsidiary of Daystrom, Incorporated 1855
Westronics Incorporated 1859
Wolverine Tube Division 1853

NEW LITERATURE

MATERIALS

MICA SELECTION. 2-page Bulletin 2661 has full-size grading chart on which user merely lays the part or sketch to estimate needed material, also provides data on mica characteristics, thicknesses, etc.—Ford Radio & Mica Corp., 536 Sixty-third St., Brooklyn 20, N. Y.

Circle **542** on inquiry card.

LAMINATE. Four-page Bulletin LT-2 covers Fluoroply-F Laminate for printed circuit applications, gives data on properties, etc.—International Resistance Co., 401 Broad St., Phila. 8, Pa.

Circle **543** on inquiry card.

FABRICATION

GEAR CUTTING. tooth grinding and other machining facilities in company's new Florida Gear Div. are described in new 4-page Bulletin 431.—Norden-Ketay Corp., Commerce Rd., Stamford, Conn.

Circle **544** on inquiry card.

CUTTING AND SHAPING BY ABRASION is explained in 8-page brochure describing Model C Industrial Airbrasive Unit for machining hard, brittle materials in lab or plant.—S. S. White Industrial Div., Ten East Fortieth St., New York 16, N. Y.

Circle **545** on inquiry card.

BOARD ASSEMBLY FIXTURE for production-line and lab, holding printed circuit boards from ¾" x ¾" to 7" x 8", is described in 2-page bulletin.—Technical Devices Co., 2340 Centinela Ave., Los Angeles 64, Calif.

Circle **546** on inquiry card.

HOT-WIRE STRIPPER for plastic-insulated wire, snap-in vice for connectors and production vise for printed-circuit boards are presented in two new 2-page bulletins.—Western Electronic Products Co., 655 Colman St., Altadena, Calif.

Circle **547** on inquiry card.

SOFT-AND-HARD SOLDERING techniques are subject of new 6-page booklet, entitled "Anchor Solder and its Proper Application."—Anchor Metal Co., Inc., 966 Meeker Ave., Brooklyn 22, N. Y.

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BORING BAR. Two-page leaflet describes "Silent Sam" chatterless boring bar.—Pensco Products, 527 Lexington Ave., New York 17, N. Y.

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WIRE, CONNECTORS

CABLE IN TAPE FORM. Folder contains various pieces of literature and several photographs describing new Tape Cable (trade mark), a flat multi-conductor electrical cable. A ribbon-like flexible film contains imbedded flat copper conductors 0.0015" thick. —Tape Cable Corp., 790 Linden Ave., Rochester 10, N. Y.

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7	32	57	82	107	132	157	207	232	257	282	307	332		407	432	457	482	507	532	557	607	632					
8	33	58	83	108	133	158	208	233	258	283	308	333		408	433	458	483	508	533	558	608	633					
9	34	59	84	109	134	159	209	234	259	284	309	334		409	434	459	484	509	534	559	609	634					
10	35	60	85	110	135	160	210	235	260	285	310	335		410	435	460	485	510	535	560	610	635					
11	36	61	86	111	136	161	211	236	261	286	311	336		411	436	461	486	511	536	561	611	636					
12	37	62	87	112	137	162	212	237	262	287	312	337		412	437	462	487	512	537	562	612	637					
13	38	63	88	113	138	163	213	238	263	288	313	338		413	438	463	488	513	538	563	613	638					
14	39	64	89	114	139	164	214	239	264	289	314	339		414	439	464	489	514	539	564	614	639					
15	40	65	90	115	140		215	240	265	290	315	340		415	440	465	490	515	540	565	615	640					
16	41	66	91	116	141		216	241	266	291	316	341		416	441	466	491	516	541		616	641					
17	42	67	92	117	142		217	242	267	292	317	342		417	442	467	492	517	542		617	642					
18	43	68	93	118	143		218	243	268	293	318	343		418	443	468	493	518	543		618	643					
19	44	69	94	119	144		219	244	269	294	319	344		419	444	469	494	519	544		619	644					
20	45	70	95	120	145		220	245	270	295	320			420	445	470	495	520	545		620	645					
21	46	71	96	121	146		221	246	271	296	321			421	446	471	496	521	546		621	646					
22	47	72	97	122	147		222	247	272	297	322			422	447	472	497	522	547		622	647					
23	48	73	98	123	148		223	248	273	298	323			423	448	473	498	523	548		623	648					
24	49	74	99	124	149		224	249	274	299	324			424	449	474	499	524	549		624	649					
25	50	75	100	125	150		225	250	275	300	325			425	450	475	500	525	550		625	650					

NEW LITERATURE

CONNECTORS of sub-miniature size are described in 12-page brochure.—Electronic Sales Div., DeJur-Amsco Corp., 45-01 Northern Blvd., Long Island City 1, N. Y.

Circle **551** on inquiry card.

RESISTOR WIRE. Eight-page catalog describes improved "Copel" copper-nickel resistance alloy made in wire or ribbon form.—Hoskins Mfg. Co., 4445 Lawton Ave., Detroit 8, Mich.

Circle **552** on inquiry card.

COPY EQUIPMENT

PHOTOPRINT MATERIALS are described in 4-page leaflet on Ozalid Intermediate Materials: papers, foils and cloths.—Ozalid, Div. of General Aniline & Film Corp., Johnson City, N. Y.

Circle **553** on inquiry card.

PHOTOGRAPHIC MATERIALS for line reproductions are described in 16-page Catalog K.—Grant Photo Products Inc., 19000 Detroit Ave., Cleveland 7, Ohio.

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SERVICES, MISCELLANEOUS

INFRARED RESEARCH is described in 16-page informative brochure "Answer-Power" with the thought that the capabilities that supplied these answers may be utilized to solve other allied problems in the infrared and electronics industry.—Servo Corp. of Am., 2020 Jerico Turnpike, New Hyde Park, N. Y.

Circle **555** on inquiry card.

FACILITY DESCRIPTION. Twelve-page brochure describes products, capabilities, and facilities of the new Magnetics Division of Servomechanisms, Inc., 100 W. El Segundo Blvd., Hawthorne, Calif.

Circle **556** on inquiry card.

ENGINEERING SERVICES available to industry for developing products, tools and machinery is described in new 4-page bulletin.—Associated Engineers, Inc., 329 Silver Street, Agawam, Mass.

Circle **557** on inquiry card.

PROJECTOR-PRINTER. Six-page bulletin describes how the Ozalid Projecto-Printer Kit can be used for making transparencies, eliminating dark-room methods.—Ozalid Div., General Aniline and Film Corp., 8 Corliss Lane, Johnson City, N. Y.

Circle **558** on inquiry card.

R&D PROGRAM. "From Raw Materials to Complete Systems" is title of 8-page facilities brochure describing company's research and development program.—Advanced Research and Development, Gulton Industries, Inc., 212 Durham Ave., Metuchen, N. J.

Circle **559** on inquiry card.

OFFICE COPY MACHINES of four different types, and how to choose them, are subject of new 4-page folder.—Peerless Photo Products, Inc., Shoreham, L. I., N. Y.

Circle **560** on inquiry card.

ULTRASONIC CLEANER. Two-page bulletin describes small self-contained Model WC-14 and some applications.—McKenna Laboratories, 2503 Main St., Santa Monica, Calif.

Circle **561** on inquiry card.

ENGINEERING SERVICES on every level from management to sales are described in large 12-page brochure laying stress on automation.—Contact Engineering Div., The Teller Co., Butler, Penna.

Circle **562** on inquiry card.

DEHYDRATION EQUIPMENT for air and other gases is described in maker's new 8-page bulletin.—Air-Dry Corp. of America, 14756 Keswick St., Van Nuys, California.

Circle **563** on inquiry card.

ASTRODOME-TYPE SHELTER for use with Cinetheodolites is described in new Bulletin CR-189.—Coleman Engineering Co., Inc., 6040 West Jefferson Blvd., Los Angeles 16, Calif.

Circle **564** on inquiry card.

COMPARATOR CHARTS and fixtures. Eight-page catalog describes custom optical comparator charts and coordinated staging fixtures, standard scales and fixture bases, master artwork and/or production negatives for printed circuitry, and precision photography.—The Industrial Lofting & Mfg. Co., Inc., Bridgeport 7, Conn.

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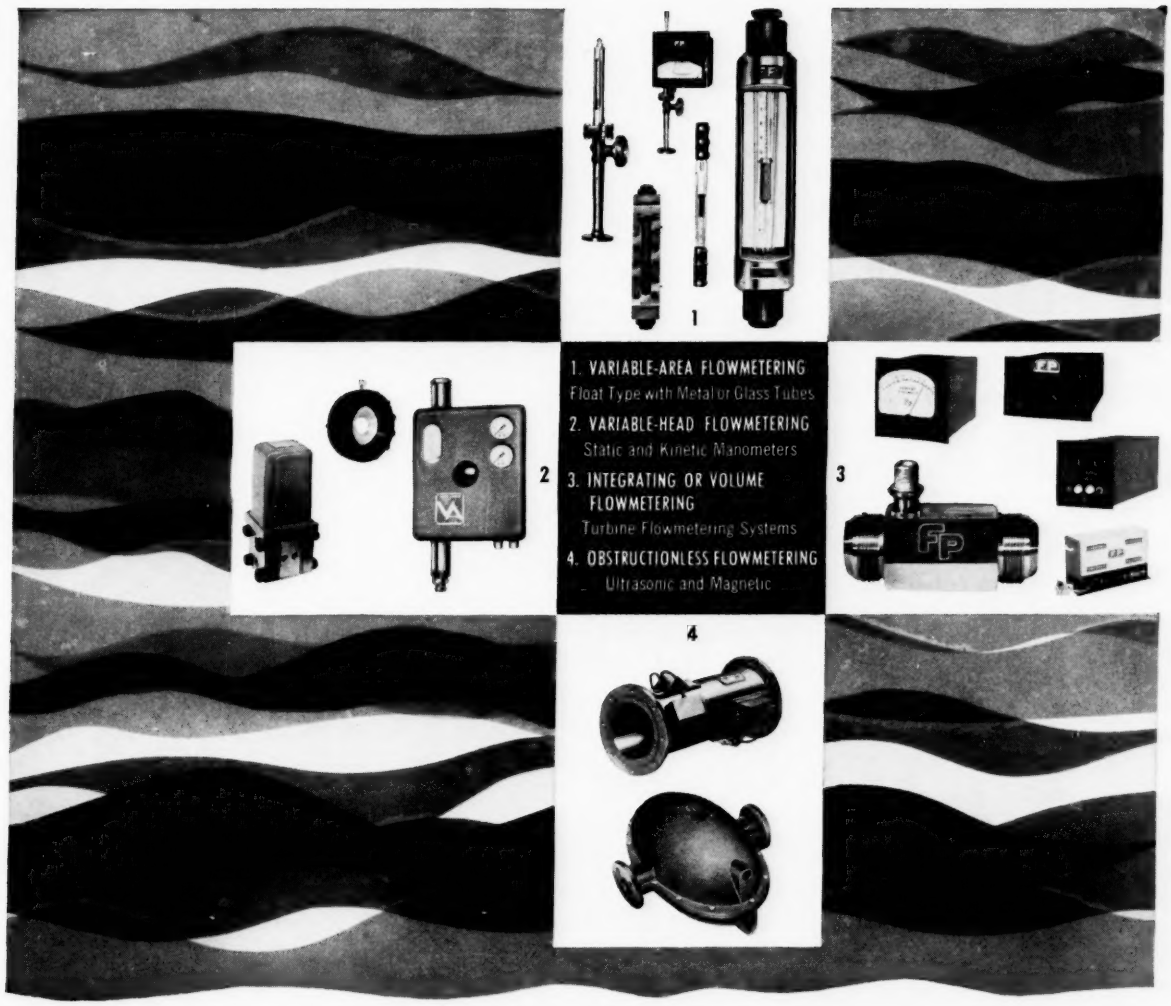

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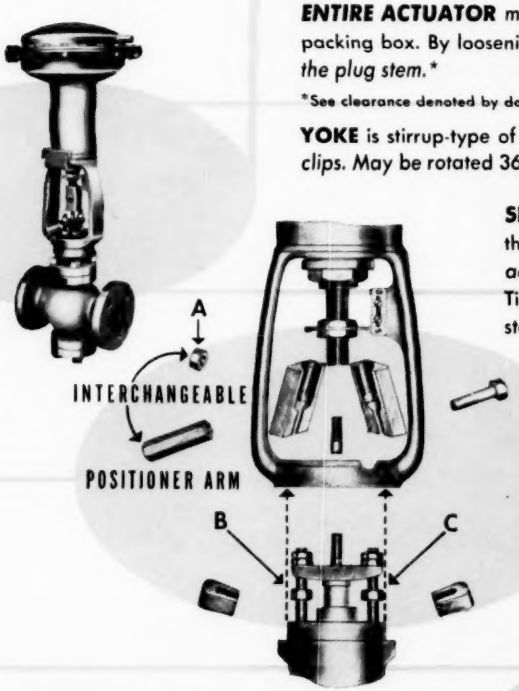

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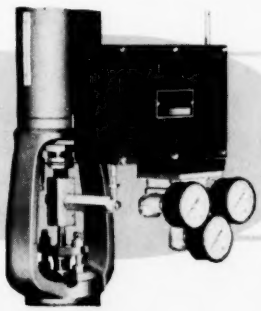

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